FOOD TECHNOLOGY

PUBLISHED BY THE INSTITUTE OF FOOD TECHNOLOGISTS

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Food for thought

"Science and Human Values in Food"

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October, 1955 Volume 9, Number 10

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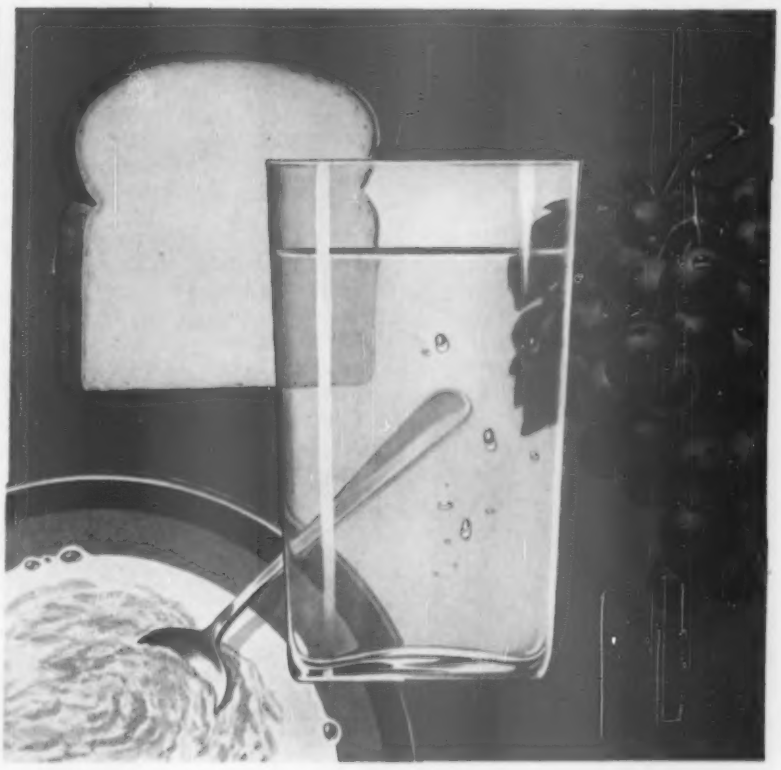

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Affairs of the Institute

Regional Section News **Recently Elected Members**
Personnel **Future Meetings**
Books **Food Industry Topics**
Selected Abstracts

It's St. Louis in 1956!

When members of the Institute of Food Technologists assemble in St. Louis on June 10, 1956, for the opening of their 16th Annual Meeting, Easterners will find themselves at the traditional "Gateway to the West" and Westerners at the "Gateway to the East." St. Louis is Missouri's largest city, the nation's eighth largest. It takes pride in its varied history which embraces the Indian lore of early America, the exploits of explorers and fur traders, and the vision and deeds of generations of city builders from all walks of life.

Although it was the site of the Jesuit Mission of St. Francis Xavier in 1700, the establishment of St. Louis as a town came more than half a century later when Maxent, Laclede and Company of New Orleans was granted exclusive rights to the Indian trade in the Missouri Valley and the country to the west. Pierre Laclede Liquest, junior partner of this firm, commissioned to found a branch in the new territory, selected St. Louis as the most suitable location in December, 1763. He announced to his 30 companions that he "intended to establish a settlement which might hereafter become one of the finest cities in America."

Within five years, Laclede's fur trade grew to more than $80,000 annually and St. Louis became and remained the fur trading center of the West. Laclede's exclusive fur trading privileges were eventually withdrawn, however, and the way was open for an influx of new settlers, merchants and adventurers. During the American Revolution, in 1779, the village's French, Spanish and American settlers were successful in repulsing a British attack, evidence not only of their regional loyalty but also of the early synthesis of the villagers into a community of kindred spirits.

Ol' Man River and River Days

Following the Revolution, St. Louis and river traffic boomed. For a while pirates swarmed the Mississippi, plundering and murdering until they were driven away by a force of tough riverboatmen who combined their brawn to "purge" the river. By 1804, the growing fur trade was valued at $203,750 annually, and St. Louis became the center of wealth and culture in the upper river valley. The great westward movement began with the Louisiana Purchase, and St. Louis, as the gateway and capital of the vast, rich, new half of a continent, drew unto itself freebooters, gamblers, explorers, and political and religious rebels. Yet amid the brawling and duels characteristic of raw frontiers, the steady commercial improvement of St. Louis continued. Between 1804 and 1806, Lewis and Clark set forth from St. Louis to open the way to the great Northwest. In 1809, the famous Missouri Fur Company was organized. In 1822, John Jacob Astor sought to compete for the $300,000 per year fur trade by opening a St. Louis branch.

Signs of substantial community life appeared in this era. In 1808, the Missouri Gazette, first newspaper west of the Mississippi, published its initial edition. That same year, St. Louis was incorporated as a village with 1400 population. The river flatboat travel southward grew steadily as the Missouri Valley farmers sent the products of their rich fields to New Orleans. St. Louis gradually assumed the political leadership of the state, playing host both to the territorial legislature and later to the constitutional convention.

The golden age of river steamboating dawned in St. Louis on August 2, 1817, when the Zebulon M. Pike, a crude, early steamboat, pushed its way upstream from Louisville to become the first steamboat ever to reach St. Louis. Soon a huge flotilla of steam-propelled vessels replaced the flatboats and keelboats to make the

city a hub of inland water trade, boosting its population from 20,000 in 1837 to 75,000 in 1850, 160,000 in 1860, and 350,000 in 1880. The progress of industry was similarly accelerated as the small home shops of craftsmen grew into the industrial enterprises which are the foundation of modern St. Louis' powerful and varied industry.

Political events in Europe provided St. Louis with its third wave of frontiersmen. Large numbers of German professional men and scholars, skilled tradesmen and artisans, dissatisfied with conditions in their homeland, began moving to Missouri between 1832 and 1850. These stable and cultivated people brought to the midwestern community new interest in education, art and industry.

The nineteenth century growth of St. Louis reflects in a sort of summary the nation's history of that period.

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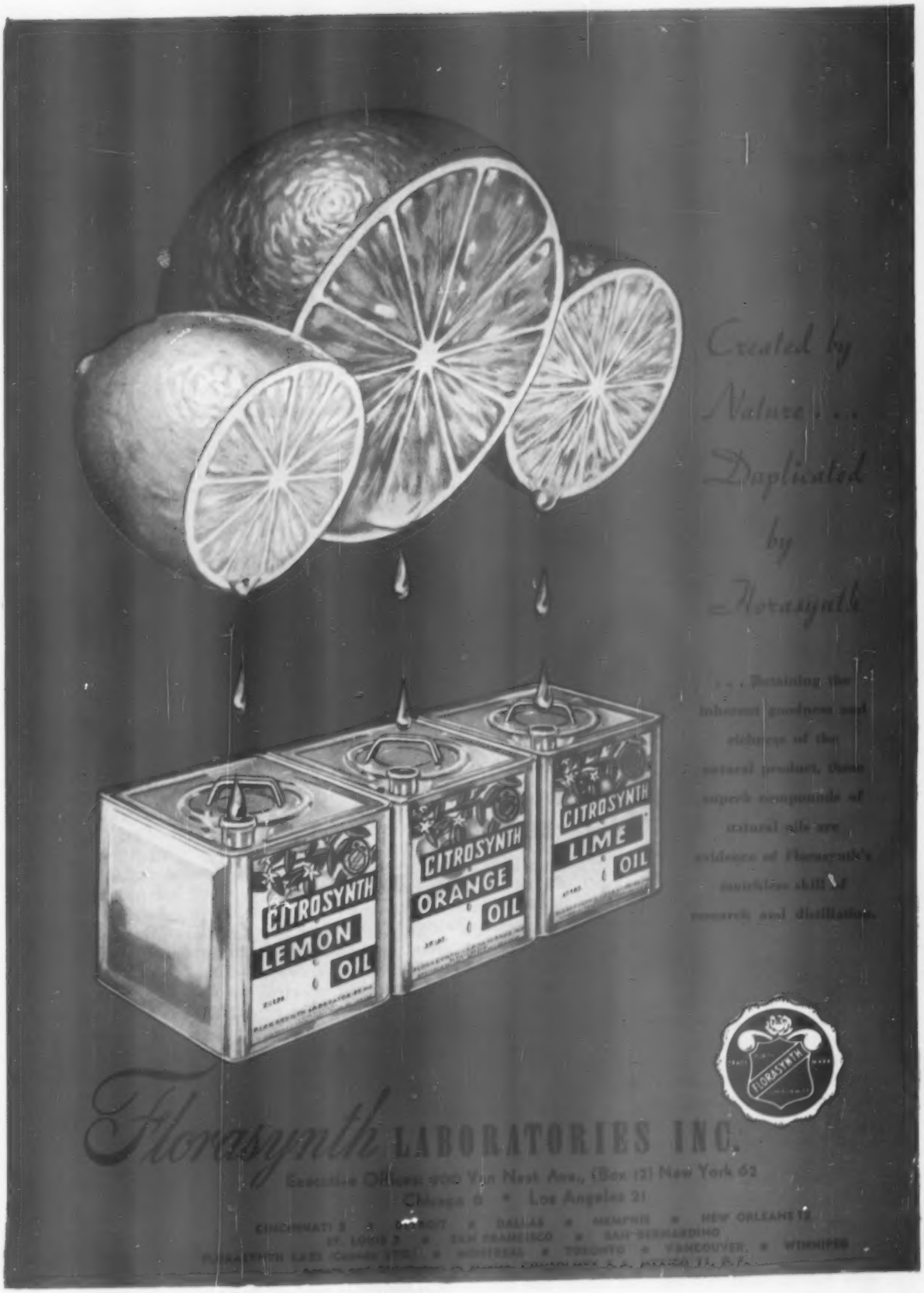
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IT'S ST. LOUIS IN 1956!

(Continued from page 4)

The development of luxurious and famous hotels, founding of colleges and universities, the spectacular westward advance of the railroads, the Civil War which divided the city into two camps before its Federalist sympathies brought it into the conflict on the side of the North, and finally the great industrial strides of the 90's: all these were a part of the picture which marked St. Louis' entrance into the twentieth century.

Today a hub city for transportation, manufacturing, commerce and finance as well as the dominant center in a wealthy agricultural area, St. Louis is the true product of its past, combining a pride in its historic heritage with the spirit of progress which made it great.

St. Louis as a Food Center. Located at the crossroads of the Nation's food production area, St. Louis is among the top five farm markets. It does an annual raw food product business in excess of eight hundred million dollars annually. Livestock and the packing industry contribute the lion's share of this business, four hundred million dollars; grain, two hundred million dollars; produce, one hundred million dollars; poultry and eggs, sixty million; and dairies, fifty million dollars.

St. Louis rather consistently is the Nation's leading hog market year after year. An average of 5½ million head of livestock are processed in St. Louis annually by packers who pay some three hundred and sixty million dollars for the animals "on the hoof" and convert them into about a billion pounds of meat and meat products. By-products of the St. Louis meat plants find their way into food industries: rennet for cheese making; gelatin for marshmallows; Sterin for chewing gum and candies; and medicine such as various hormones and glandular extracts; insulin, pepsin; Epinephrine, ACTH, cortisone and many other non-food industrial products. Livestock is handled through two stockyards the largest of which is National Stockyards on the east side of the Mississippi and the Mississippi Valley Stockyards on the west bank.

Thirty-eight packing houses, ranging in size from very large to very small, process about 5% of the total national supply. St. Louis packers net just about what they paid for livestock from the sale of the 55% meat yield of the animals.

St. Louis is the national home of Ralston Purina Company which is the Nation's leader in the mixed feed industry. Originally dedicated to the improvement of human health through whole grain cereals, the company has expanded nationally principally in livestock feed production but at the same time constantly adding new brands of the dry prepared cereals.

St. Louis boasts one of the Nation's newest and most modern produce markets. Built by private capital at a cost of over three million dollars, St. Louis' produce market is now nearing its 3rd birthday. From all 48 states and from 10 to 15 foreign countries, St. Louis receives fruits and vegetables by rail and truck. Nearly all the produce arriving in St. Louis is distributed through the new facility. Most of the produce arriving in St. Louis is distributed through two parallel buildings each one thousand two hundred twenty-five feet long separated by a one hundred and twenty foot center driveway. It accommodates fifty-seven merchants, fifty-one of whom are stockholders in the corporation. Bananas, cellophane wrapped on arrival, are hung in "ripen rooms." Tomatoes, similarly, have their own ripen rooms. Comparable care is accorded to other produce received for distribution. Selling at the market begins early in the morning and produce reaches most retail stores by or soon after the stores open. Citrus fruits are sold at the American Central Fruit Auction where wholesale lots go to the highest bidder.

Forty-two dairies receive milk from producers in the St. Louis milk shed which covers nearly one hundred Illinois and Missouri counties. Newly initiated on the part of some dairies is bulk tank pick-up and delivery. St. Louis dairy companies are constantly on the alert to bring quality milk products to the consumer's table at a cheap price and at the same time reward the farmer for his dairying efforts.

Milk is distributed through St. Louis dairies to stores and homes in both glass bottles and paper containers. Many of the large dairies have dual operations and one large dairy and a small number of plants restrict their operations to paper cartons.

A City of Versatile Resources

St. Louis is the home of a number of food specialty firms. Some of them engage in processing special grains into macaroni and related products, special food dyes, bio-chemicals, preserves, salad dressings, olives and pickles, yeast, syrups and flavorings.

Eckert's market near Belleville, Illinois, a suburb of St. Louis, is most unusual in the research they have conducted and the products offered to the public at their roadside market. Eckert's early earned a reputation for high quality tree ripened peaches. Later they prepared apple juice and apple cider. Today beef animals grown on the farm are marketed through their grand super market, as are also fresh eggs and fruits supplemented with a complete line of grocery products.

St. Louis is one of the few major cities in which the State University maintains an office and staff to advise consumers of quality products at low cost and methods of incorporating their use in menu planning.

G. S. Suppiger and Company operates a canning plant near Collinsville, Illinois which is in the Metropolitan area. Tomatoes, catsup, peas, asparagus, and corn are their principal products.

St. Louis county vegetable growers are members of two grower associations. St. Clair county Illinois growers have their own association. The organizations work toward better markets and improved quality but do market under the name of their association. Vegetables from nearby farms provide the greatest bargain to consumers for vegetables in season.

St. Louis, being the center of a large trading area, has a large number of bakeries, potato chip plants and numerous specialty industries. These products are sold in a wide area surrounding St. Louis and many of them nationally.

Food and beverage manufacturing and processing head the list of industries both in value added by manufacture and in total number of employees.

(Continued on page 8)

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IT'S ST. LOUIS IN 1956!

(Continued from page 6)

The 34,100 St. Louisans engaged in food and beverage processing are in widely diversified activities ranging from pickle processing to the preparation of dried and dehydrated fruits and vegetables.

The macaroni industry produces for both the local and the national market and its distribution is particularly strong in the South and Southwest.

The coffee industry, represented by many well-known brands in the St. Louis area, is aimed primarily at a regional market.

Second largest brewing city in the nation, St. Louis is the home of the world's biggest brewery. Breweries in the area employ approximately 7,500.

In the soft drink field, St. Louis production is geared to demands of the regional market. The national figure for consumption is 175 to 180 bottles per person per year and St. Louis is far ahead of the national average. St. Louis and the county consume over 12 million cases a year.

Regional Section News

NORTHERN CALIFORNIA SECTION

Wine Technology. The Section held a joint session with the Delta Sub-section on August 18 at Lou's Village, San Jose, Calif. A panel discussion was held on wine technology. The principal areas of discussion centered around (1) the stuff the vintner buys; (2) the production of wines; and (3) research, quality and taste. Walter S. Richert, ex-President of the American Society of Enology and winery owner at Madrone, handled (1) raw materials; Leo A. Berti, currently Production Manager of Paul Massons, one of the oldest fine wine producers in California, discussed (2) production; and Harold W. Berg spoke on (3) research.

Picnic. A group of about 200 IFT members and their families attended the Section's Annual Picnic held at Adobe Creek Lodge.

Tribute. From *The Hornblower*, July-August issue, *re* June 2nd meeting held in the Fairmont Hotel during which a presentation was made to Dr. Cruess:

"The June 2nd meeting was a rare and nostalgic experience. The Terrace Room was well filled. B. G. Grossi gave a speech of welcome after a good dinner. Maynard Joslyn was an excellent Master of Ceremonies. Ernie Jacobs presented the Cruess Award. Hugh Griswold presented Professor Cruess the Prescott award. Mayor Claude B. Hutchison spoke of past experiences at the University with Bill Cruess. Vice President H. B. Wellman spoke of the present University and Bill Cruess. Dr. Paul Sharp spoke of Bill Cruess and Food Technology. Ray Junk presented Dr. Cruess the testimonial letters which came in from friends of Bill's from this country and abroad. Emil Mrak presented the collected works of Professor Cruess.

"Mrs. Cruess then became the center of the stage as Maynard Joslyn unveiled the portrait of Bill which she had so lovingly painted. This portrait will be hung in the hall of fame in the Food Technology Building.

"Finally Bill made the fine response to all this honor and glory, but as you and I would expect he was very touched and pleased that we would go all out and was most appreciative of all that every one had done.

"It was a real pleasure Bill, both for those that had a major or minor role in preparation and presentation, and for those who just sat and enjoyed it."

MARYLAND SECTION

The Vanilla Story. At the Maryland Section's Meeting, June 10th at McCormick and Company's Little Theatre, business was held to a minimum and technical and social features were accented. Dr. Hall introduced Mr. Louis Towt of McCormick and Company, who besides being a vanilla expert proved to be an excellent motion picture photographer and editor.

Mr. Towt showed a magnificently prepared film on vanilla—its habitat, processing, packaging, transportation, and even the final extraction and packaging of the extract.

Most of the vanilla found on the market today is grown in either Madagascar or Mexico. Here can be found the ideal conditions for growth—high humidity and temperature. Also, there is an abundance of sunshine for curing and low cost labor for handling over a five-month period. In order to have high grade vanilla it is necessary to grow it under host trees which provide exactly the right amount of sun and shade. So, host trees are neatly planted first; then, after attaining proper size, the vanilla plant slips are set beside the host tree. Being a vine, the plant climbs toward the top of the tree and, when mature, blooms.

The vanilla plant is a member of the orchid family and its flowers are accordingly quite beautiful. In order for the vanilla beans to mature to sufficient size for marketing, some of the lovely orchid blooms are thinned out. Then artificial pollination is performed on each remaining flower by experienced pollinators. Soon the flower withers and the long pod develops, which is to contain the vanilla bean.

For best vanilla production, beans are hand-harvested at the peak of their maturity and placed in baskets. These are carried to small processing plants in the villages where they are first plunged into hot (temperature variation wide) water and placed in the sun on trays to dry. Since rain ruins their quality, at the approach of every suspected rain, the beans must be gathered from the drying trays manually and placed under cover. When five months and much labor have been consumed, the beans, now dark, withered and fermented to the proper state, have the characteristic "vanilla" aroma. Processors hand-pack these beans into neat bundles, about three and a half inches in diameter, and tie them tightly with three strings. (In Madagascar the two end strings are cut, but in Mexico all three are left on, for export.)

Beans are graded by weight, aroma, freedom from mold and foreign matter; they are then packed in tins to await export, after the buyer has singled them out. After arrival in this country (the U. S. A. is the chief importer), they go to extract houses such as McCormick and Company where further processing takes place.

(Continued on page 10)

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REGIONAL SECTION NEWS

(Continued form page 8)

In the extraction process, the beans are blended and comminuted to the proper size. Then the mixture is placed in extractors or percolators in perforated baskets. The extraction solvent is run over them until the extract tests up to standard. After the final standardization, the extract is bottled, labeled, and packed for the consumer.

Vanilla shows up in America in many products—chocolate, ice cream, bakery products, candy, beverages, and perfumes. As time goes on, the popularity of vanilla increases—although lately Vanillin is replacing it to some degree.

Mr. Towt told of a new curing process taking only 48 instead of the now required 3,650 hours. It involves making a puree of the green bean and heating. This is not acceptable to growing areas though, due to resulting economic changes. In time, however, the better process will come into use.

At the conclusion of the technical meeting, McCormick and Company's Staff, namely Dr. Hall, Dr. Kuhl, Mr. Karas, and Mr. Graves, served us refreshments and then allowed us to inspect their new test kitchen and taste panel rooms. This particular development is the latest in design and a model for this type of technology.

SOUTHERN CALIFORNIA SECTION

Invitation.

October 28, 1955, at Pasadena, California. You listen to the man on TV crunch high-fidelity crunches. You watch the beer-can logs roll down the mountain-cool water. But as a scientist you know that without paper, plastics, wax, and metal containers these marvels of food preservation would not be on the market. Understandable that Pfizer and Kraybill should know something about food preservation — but what is North American Aviation doing on a food preservation program? What is the latest in radiation applications, in antibiotics, and anti-oxidants? What does The Law have to say about food preservation? Are there no unsolved problems in your plant, or would you like to find out how the leading companies in the food industry do it?

Then come to the 8th Annual Conference of the Southern California Section of the Institute of Food Technologists Friday, October 28, at the Huntington-Sheraton Hotel, 1401 S. Oak Knoll, Pasadena, Calif. for an all-day session on all phases of food preservation including high-energy radiations, new low-temperature techniques, foils, films, and aerosols.

PERSONNEL

On the program of the important "Internation Conference on the Use of Antibiotics in Agriculture" (October 19-21, 1955, Jefferson Memorial Stadium, USDA, Washington, D. C.) a number of prominent IFT members have key roles. Included are Drs. H. L. A. Tarr, F. E. Deatherage, and Emil Mrak. They are participants in the fourth session (October 21) one part of which is devoted to the place of antibiotics in food preservation. The National Academy of Sciences—National Research Council is sponsoring the conference cooperatively with Agricultural Research Institute, the American Cyanamid Company, Merck and Company, Charles Pfizer and Co., Inc., and E. R. Squibb and Company.

Newly appointed to a post in the Research and Development Division, Office of the Quartermaster General, Washington, D. C., is Kevin G. Shea, formerly with B. Heller and Company, Chicago.

Leander H. Walker has established himself in Berkeley, California, as a consulting chemical engineer. He was formerly engaged in products research in the Fruit Section, Western Utilization Research Branch of the U. S. Department of Agriculture.

Dr. Harold S. Olcott, Department of Agriculture food specialist, has been chosen as Professor of Marine Food Technology and Marine Food Technologist on the staff of the University of California's state-wide Institute of Marine Resources. He will work on the Berkeley campus of the University. The establishment of the position is part of the planned development of the University's Institute of Marine Resources, established in 1953. Its headquarters are on the La Jolla campus of the University. Dr. Olcott will also be directly associated with the Department of Food Technology, Berkeley, and will direct research work leading toward advanced degrees in food science and comparative biochemistry.

The American Agricultural Chemical Company has appointed Dr. G. H. Benham director of the company's research and process development program. Dr. Benham will make his headquarters at the company's offices, 50 Church Street, New York, N. Y., after September 1st, 1955. Dr. Benham has for the past five years been associated with Armour Research Foundation, Chicago, in charge of biochemistry research.

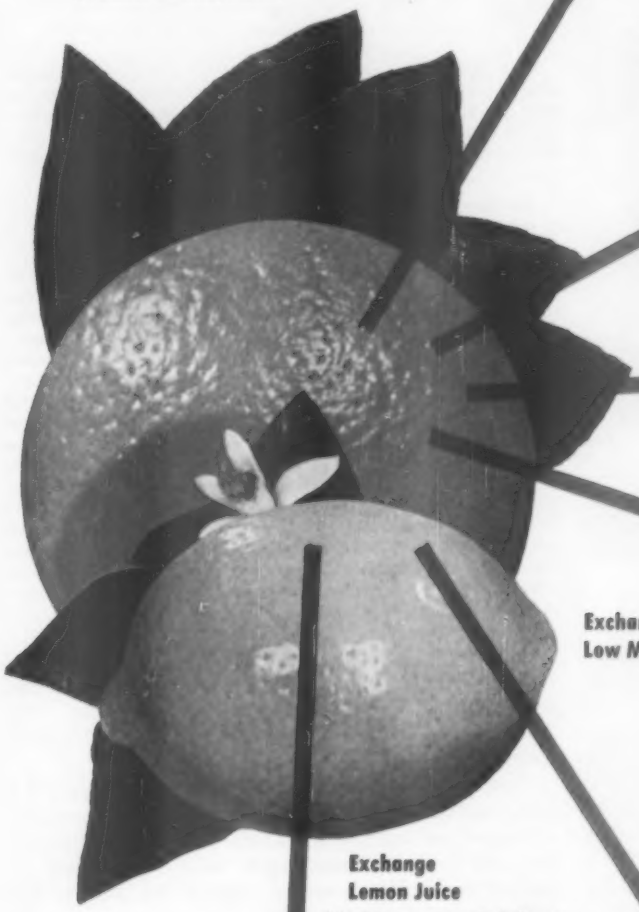
FUTURE MEETINGS FOR FOOD TECHNOLOGISTS

1955	
October 19-21	Symposium on Applications of Radioactivity in the Food and Food Processing Industries, Sheraton-Plaza Hotel, Boston, Massachusetts
October 19-21	First International Conference on the Use of Antibiotics in Agriculture—Sponsored by the National Academy of Sciences—National Research Council, Washington, D. C.
October 31-November 2	Seventeenth Annual Forum of the Packaging Institute, Hotel Statler, New York, N. Y.
November 16, 17, 18	National Convention of the Association of Food Industry Sanitarians, Hotel El Rancho, Sacramento, California
1956	
March 15, 16	First International Symposium on Physics in the Food Industry, Plaza Hotel, San Antonio, Texas
April 8-13	One hundred and twenty-ninth National Meeting of the American Chemical Society, Dallas, Texas
June 10-14	**Sixteenth Annual Meeting of the Institute of Food Technologists, Hotel Jefferson, St. Louis, Missouri**

(Information concerning future dates of national and international meetings, conventions and exhibits of interest to food technologists should be sent to the editorial office.)

Look to Sunkist
for progressive research in food processing

Yes, in every field of food processing, the Sunkist Growers laboratories are making ever-widening contributions to the increased quality of food products. Here are some typical Exchange Brand product developments.



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The 4-to-1 favorite over all other lemon oils combined! The reason is the superior flavor that comes only from California-grown lemons processed by exacting Sunkist standards.

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Here is *even* jell strength that gives you consistent, complete reliability in setting control.

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A natural fruit pectin that jells without sugar. Completely tasteless, permitting the use of the most delicate flavors. Pies made with Exchange Low Methoxyl Pectin won't "run" or "weep" when cut—and you have never tasted such natural juicy fruit flavor. Famous too for aspics, jellied fruit or vegetable salads, dietetic preserves or non-sugar jells.

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Nothing can match lemon juice for bringing out the natural flavor of *any* food product. It's a superior acidulant in the preparation of mayonnaise, fruit cocktail, figs, fruit nectar, prunes and other heavy-syrup products. Highly effective as an anti-oxidant in processing frozen foods. Citric acid molecules have also been established as effective in the retarding of mold growth. Available in concentrated or single strength form.

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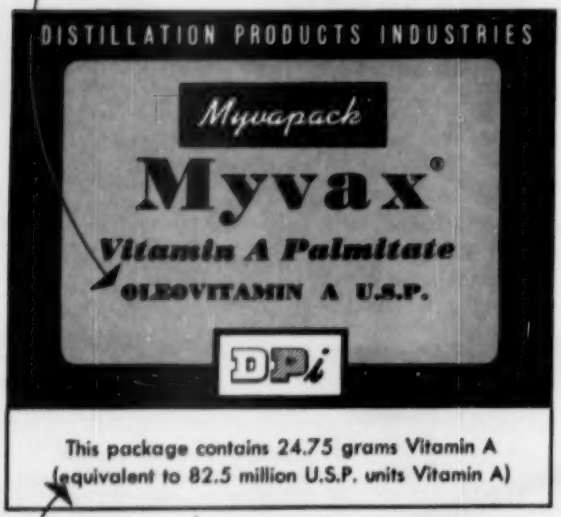
The fifteenth revision of the U. S. Pharmacopoeia was issued July 1, 1955 to become official December 15, 1955. A monograph has been set up for bulk vitamin A products. To meet it, our products needed a change only in the labels.

To conform to the new revision, the labels on Myvapack® Vitamin A will look like this:

The word "Oleovitamin A" indicates that the product meets all the U. S. P. standards for solutions of vitamin A esters in edible vegetable oil.



The content of vitamin A, as in the past, will be shown as the total number of U. S. P. Units of vitamin A in the package. In addition, to follow the practice of U. S. P. XV, we show the equivalent weight of vitamin A according to the relationship that 1 U. S. P. Unit equals 0.3 micrograms of vitamin A.

This change in our label calls for no change in your labeling of food products with vitamin A added. You order Myvapack Vitamin A in batch-premeasured cans containing either Myvax® Vitamin A Acetate or Palmitate from ***Distillation Products Industries,*** Rochester 3, N. Y. Sales offices: New York, Chicago, and Memphis • W. M. Gillies and Company, Los Angeles, Portland, and San Francisco • Charles Albert Smith Limited, Montreal and Toronto.

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12

Books

NOTES IN BRIEF

Cookbook for Diabetics Announced for Fall Publication. A new cookbook, THE DIABETIC'S COOKBOOK, is being published this fall by the Medical Arts Publishing Foundation. It will contain 250 recipes for preparing beverages, pastries, desserts, fruits, meats, salads, sandwiches, and vegetables. American Diabetic Association values and exchange lists are used throughout the book. Also, pages are included for the diabetic to fill in his own diet prescription. Every recipe shows total amounts of carbohydrates, proteins, and fats as well as the caloric value of each serving. Author of THE DIABETICS COOKBOOK, is Mrs. Clarice B. Strachan, of Tulsa, Oklahoma, who combines "a scientific background with the artistry of the kitchen to produce a volume which will add variety and zest to the diabetic's menu." THE DIABETIC'S COOKBOOK is published by The Medical Arts Publishing Foundation, 1603 Oakdale Street, Houston 4, Texas.

IFT Authors. Among the authors or editors of technical books in the field of food research and technology issued during 1955 are Dr. Fred C. Blanck, editor of Reinhold's comprehensive HANDBOOK OF FOOD AND AGRICULTURE and Dr. Belle Lowe, Iowa State College, author of a revised edition of EXPERIMENTAL COOKERY, a classic in its field.

An Unusual Cookbook. Books on cookery abound, and some of them are sent to FOOD TECHNOLOGY for review. THE TENTH MUSE, by Sir Harry Luke, is the most recent of such offerings. The publisher, John de Graff, Inc., 64 West 23rd Street, New York 10, supplies this quick characterization of Sir Harry's contribution—"a wealth of gastronomic observations and suggestions as well as an unusual and eclectic collection of recipes." We also learn from him that "sheiks, millionaires, peasants, Dervishes, and Gourmets of the Old School have been his hosts." The author has ranged over the entire world for his gastronomic tips and recipes. The style is at times heavily allusive and reminiscent of that of a young man of the 18th Century taking sophisticated notes while on a traditional "grand tour" of the Continent. But the book is full of interesting lore on cookery. An interesting feature is the author's careful accreditment of his sources—for example, his acquisition of a *risotto de scampi* (crawfish) from Mr. and Mrs. R. T. Smallbones, of Koludarz, Dalmatia. Mr. Smallbones' Croatian cook, Felix, is also a contributor. Many of the receipes sound enticing—and the non-enticing are at least provocative.

INDUSTRIAL AND MANUFACTURING CHEMISTRY, Part I, 7th Edition, Organic. By Geoffrey Martin, revised by Edward I. Cooke. Philosophical Library, Inc. New York 16, New York, 752 pages. Reviewed by Roy E. Morse, Chicago 12, Illinois.

Contrary to the practice now commonly employed in this country where authorities upon the various aspects of a problem contribute chapters on their own specialties, this book has been largely written by Martin and revised by Cooke. However, many of the sections have collaborators from the field. The preface states this book to be a treatise on applications of organic chemistry to manufacturing covering both England and America. It is intended for use as an authoritative text by business men, students, lecturers, and others. Emphasis is put on production figures, minor industries and by-product utilization.

There are 24 major industries covered of which edible oils, sugar, starch, fermentation, industrial gums, natural dyestuffs, glue and gelatin seem most useful to food technologists. While the impression gleaned from perusing the preface is that this book will bring the reader up to date on the field covered, there is good

(Continued on page 16)

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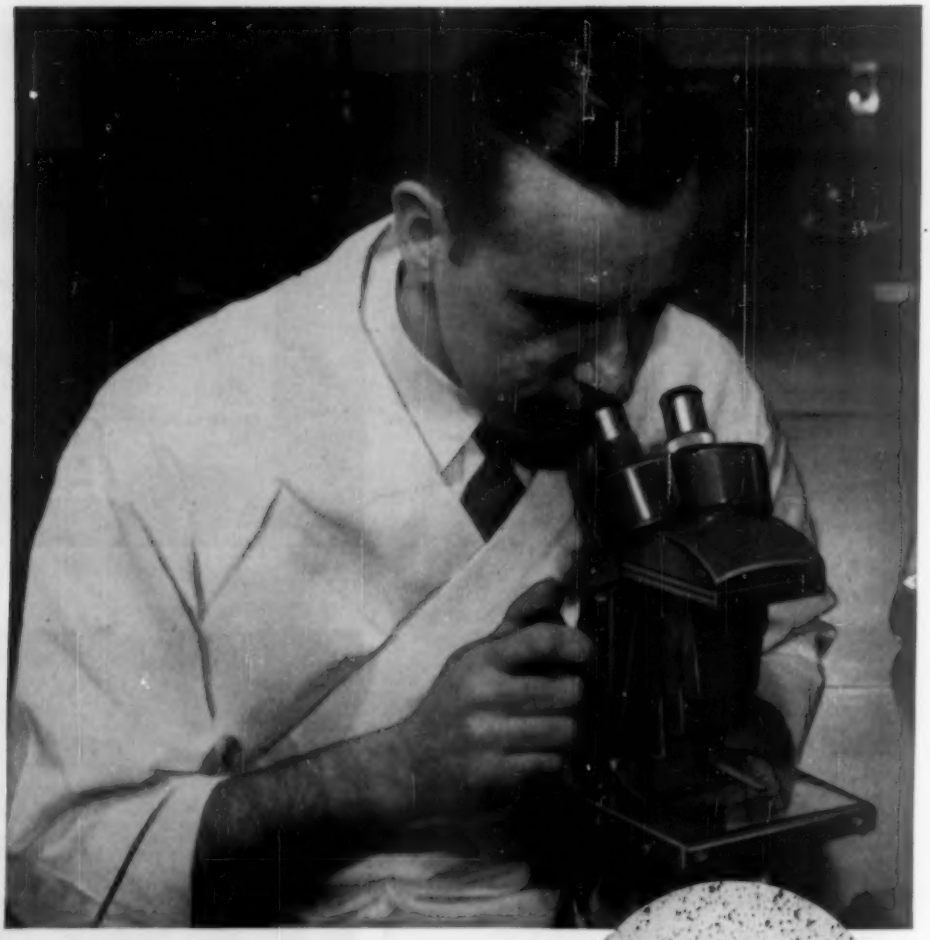


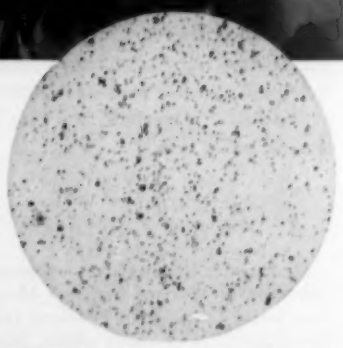
In the laboratory of Wm. J. Stange Co., a food technologist compares 50-A micro-ground Spice with ordinary ground spice under a microscope.

NEW MICRO-GROUND SPICES

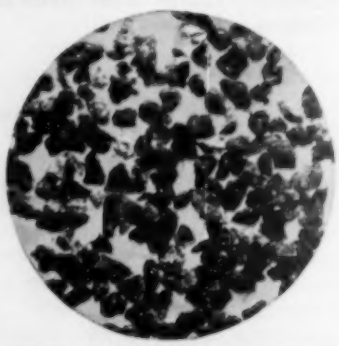
Although spices themselves haven't changed in a thousand years, unsuspected qualities have been discovered in them by a recently developed process called micro-grinding. Patented by Wm. J. Stange Co., this process consists of feeding whole natural spices into specially designed water-cooled roller mills which pulverize the spice into particles so minute, that only thru a microscope can you appreciate their size. Compared to ordinary grinding methods, the new process produces 50 to 100 times more particles of spice . . . millions more per pound.

The minute size and vast number of spice particles permit uniform and thorough distribution throughout each batch of food product, eliminating specking or the formation of hot spots.

Most important, however, is the standardization of flavor made possible by this unique process. This, in addition to the total utilization of flavor from the spices themselves makes this new spice one of the really important developments in the food processing industry.



MICRO-GROUND Black Pepper spice particles (here magnified 30 times) are practically invisible to the naked eye.



ORDINARY ground (50 mesh) black pepper particles (also magnified 30 times) appears as huge boulders by comparison with micro-ground spice.

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- **Maximum availability of flavor**
- **Constant control of flavor intensity**
- **Maximum retention of flavor**
- **Constant spice levels during shelf life**
- **Easy to use, powder form. Available in 50 to 250 pound bulk containers, or in exact-weight, batch size packages.**
- **Available in individual spices or complete seasoning blends**

For complete details on applying new Micro-Ground 50-A Spices to your fine foods, write, wire or phone—

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View of battery of special roller mill equipment processing natural spice into 50-A Micro-ground Spice. The large steel rollers, between which the spice is ground, are perfectly smooth and turn at differential speeds to cause a shearing action between the smooth surfaces. Rollers are water-cooled internally to maintain the spice at a low temperature and to prevent loss of volatile flavors.

MICRO-GROUND SPICE..... .....ORIGINATED BY STANGE

Wm. J. Stange Co. who last year celebrated its 50th anniversary, spent more than two years perfecting the micro-grinding process. Sold under the copyrighted name of 50-A Spice, these new seasonings are fully protected by patents and supplied to the food industry by Stange exclusively.

Not only are individual spices: pepper, nutmeg, cinnamon, etc. available in micro-ground form but in combination with soluble C.O.S. (Cream of Spice) Seasonings. These special blends are called Micro-Cream. By combining the two types of spices, 50-A and C.O.S., Stange can now produce seasoning blends utilizing the special advantages of each to achieve the most satisfactory flavor, color and solubility in the finished product. Micro-Cream spice blends, too, are flavor controlled to insure uniformity.

STANGE'S EXPERIMENTAL KITCHENS, laboratories and technical staff are available to develop special seasoning blends, or assist you in creation of new products.

BOOKS

(Continued from page 12)

reason to suspect it serves best to introduce the novice to the terminology and literature sources of a particular field. This must be obvious by observing the coverage attempted in a mere 752 pages, of which 672 are text and 79 are reference material. For example, in the vinegar section under fermentation industries, the industry is covered in two pages. The latest literature reference is 1911 and the equipment illustration is dated 1911.

In the section on compressed yeast, the equipment illustrated is of the type used before World War I and no mention is made of the Hayduck or differential fermentation process—without which a present day yeast producer could not hope to be competitive. If the fields selected are typical of the remainder of the book, it must be considered that the text and illustrations are hopelessly out of date for American operations and it is almost dangerous to have the text available to the novice lest the 1955 publication date imply current information. However, the illustrations and type style are in good keeping with the information supplied.

RADIOISOTOPES IN BIOLOGY AND AGRICULTURE. Principles and Practice, by C. L. Comar, McGraw-Hill Book Company, Inc., New York, 481 pp., 1955.

Isotopic tracer methods now are widely used in research in the biological and physical sciences. Tracer methodology began with the early demonstration of Georg von Hevesy of the applicability of naturally occurring radioactive isotopes of some of the heaviest elements in biological and chemical research (in 1923 he published his now classical paper on the circulation of lead in plants) and the brilliantly planned and conducted investigations of Rudolf Schoenheimer with stable heavy isotopes which lead to a new concept of the state of body and tissue constituents. Even during the period before 1940, investigations in this field were so numerous and important that von Hevesy was invited to prepare a review of the application of radioactive indicators in biology for the 1940 edition of Annual Review of Biochemistry and this was followed by Martin Kamen's review in 1947, for during the intervening period, despite wartime restrictions on isotope supply and research time, over 450 papers in this field appeared. There are now available some six texts including the present one dealing specifically or largely with the application of radioisotopes in biological research, von Hevesy (1948), Calvin et al. (1949), Kamen (1947, revised 1951), Siri (1949), Sacks (1953), and one in press, Aronoff (1955). In addition numerous reviews, symposia, etc. in biological and medical physics are available, including the symposium on the use of isotopes in biology and medicine held at the University of Wisconsin in 1948. The ready availability of radioactive istopes prepared and distributed at the Oak Ridge National Laboratory and the successful engineering of improved assay equipment commercially available has resulted in an ever increasing use of radioisotope techniques in the investigation of various physiological and biochemical reactions. Radioisotopes have played an important role in the elucidation of chemical pathways of animal and plant metabolism, mechanism of enzyme action, and browning reaction, to mention a few fields of direct interest to food scientists and technologists.

Although the early application of heavy isotopes (hydrogen, carbon and nitrogen) were made by trained biologists and biochemists, those of radioisotopes were made by physicists and chemists. Comar, in order to interest the trained biologists who are not now using radioisotopes, and to stress the importance of biological and biochemical training in selection of problems for investigation and for sounder interpretation of results, purposely has stressed the basic principles involved in this methodology rather than the chemical and physical details of the experimental methods. The biological and practical aspects of the subject, the basic principles and inherent difficulties of tracer studies, and typical facilities and methods required for studies with plants, laboratory animals and domestic animals are discussed. The difficulties inherent in this method of presentation are quite obvious in Chapter 6 which summarizes the properties and procedures for some 60 individual isotopes in a catalogue fashion. Although more of the 122 pages allowed were devoted to calcium (5 p.), carbon (8 p.), iodine (5 p.), iron (4 p.), phosphorus (5 p.), sulfur (5 p.), than to others, due justice to these elements could not be done. The book purposely was designed not as a handbook of radio-chemical or radiobiochemical techniques which can be followed, but as a guide for biologists with training in quantitative chemistry. However, unless the reader is familiar with nuclear physics and instrumentation he will have difficulties in following some of the discussions and will not be in a position to apply the principles presented to his particular problem unless he consults the literature or obtains assistance from others. The applications selected of the principles discussed, and the details of the experiments described, were chosen largely on the basis of the author's interests and research, and although an attempt was made to cover the field broadly, are taken largely from the animal field. Recent important applications in food science which might have been included are not mentioned. It is more of a text for a course in this field than a readily useful reference. On the other hand it is well written, and contains over 110 general references and almost 800 cited references to the literature in the field. A glossary of selected terms in nuclear science, code and availability of U. S. Atomic Energy Reports, and a summary of available radioisotope preparations taken from the 1955 catalog and price list of the Oak Ridge National Laboratory are included.

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2 minutes, 12 seconds: PY-RAN dough remains at bottom. The other calcium phosphate has evolved so much CO_2 that doughball floats to top.

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Selected Abstracts*

ANALYTICAL METHODS

Some observations on the colorimetric determination of vanillin.
ENGLIS, D. T., MILES, J. W., AND WOLLERMAN, L. A. *J. Assoc. Offic. Agr. Chemists, 38,* 519-23 (1955).

Reduction in the amt. of Na_2CO_3 specified in the modified Folin-Denis method lessens the tendency toward formation of an objectionable ppt. without any disadvantage in regard to color development. The pptn. tendency can be entirely eliminated by introduction of a small amt. of sodium hexametaphosphate when the usual quantity of Na_2CO_3 is employed. No significant change in final pH results from introduction of the metaphosphate.

High-resolution autoradiography of water-soluble substances.
CANNY, M. J. *Nature, 175,* 857-8 (1955).

Rapid drying of the stripping film permits examn. of substances which are H_2O-sol. if care is taken to insure that the H_2O-sol. substances in the section do not move.

A modified method of filter paper electrophoresis.
ZENTNER, H. *Nature, 175,* 953 (1955).

In the course of work on the sepn. of protein fractions from wheat gluten by means of paper electrophoresis, it was found that good resolution of hitherto unresolved fractions could be achieved by paper electrophoresis using long strips and high voltages over an extended period of time.

BIOLOGICAL SCIENCES

BIOCHEMISTRY

A sensitive method for the estimation of hydrogen peroxide in biological materials.
ANDREAE, W. A. *Nature, 175,* 859-60 (1955).

The method utilizes the principle of coupled oxidation. The disappearance of the fluorescent peroxidase substrate scopoletin is observed with a fluorometer. There is a quant. relationship between the amt. of H_2O_2 added and the disappearance of scopoletin.

Influence of formic acid on the hydrolysis of tissue proteins. A new and rapid method of hydrolysis of proteins.
GURNANI, S. U., KUMTA, U. S., AND SAHASRABUDHE, M. B. *Biochim. et Biophys. Acta, 16,* 553-7 (1955).

A new method of hydrolysis of tissue proteins with formic acid HCl is described which possesses the specific advantage of curtailing the time of hydrolysis without impairing the release of amino-acids. The efficacy of this new procedure over standard methods of hydrolyzing proteins has been established with the help of microbiol. methods. It is not advisable to use this method for tryptophane.

Reactions of long chain amines. V. Reactions with sugars.
ERICKSON, J. G. *J. Am. Chem. Soc., 77,* 2839-43 (1955).

Aldohexoses react with primary long chain alkylamines at room temp., giving N-alkylglycosylamines in good yields. Observations are offered regarding the stability and ease of hydrolysis of these compds. Ketohexoses react with primary long chain amines at room temp. to form the corresponding N-alkylketosylamines, as well as substantial amts. of products formed from 1 mole of sugar and 2 moles of amine. At higher temps. several moles of amine may react with 1 mole of either aldohexose or ketohexose. Reducing disaccharides may also react with more than 1 mole of primary amine. Possible structures for these products are discussed.

Adsorbtion-dialysis, an extraction technic, use in recovery of amino acids.
HUNTER, I. R., HOUSTON, D. F., AND KESTER, E. B. *Anal. Chem., 27,* 965-8 (1955).

Slurries of an adsorbent and the material are sepd. by a semi-permeable membrane and agitated. Amino acids and other substances of low mol. wt. diffuse out of the material and through the membrane. When a cation exchange resin is used as an adsorbent, compds. contg. basic groups such as amino acids are selectively removed from soln. and nonbasic components are rejected. The concn. of adsorbable material in the dialyzate above the resin is accordingly reduced, permitting addnl. amts. to diffuse through the membrane. The adsorbed substances are easily recovered from the resin by elution with NH_3. The method yields considerably larger amts. of amino N compds. in higher concn. than extn. with H_2O or aq. alc.

Low and high pH effects in serum albumin.
SARORF, H. A., LOEB, G. I., AND SCHERAGA, H. A. *J. Am. Chem. Soc., 77,* 2908-10 (1955).

Recently, the suggestion has been made that serum albumin has a greatly expanded or unfolded configuration at low and high pH. It is the purpose of this note to point out that heterogeneity may play a role not heretofore considered, thereby raising a question about previous interpretations based on the assumption that the albumin is monodispersed. This heterogeneity at low and high pH is observed in both human and bovine serum albumin.

Hydroxylysis in proteins.
HAMILTON, P. B., AND ANDERSON, R. A. *J. Am. Chem. Soc., 77,* 2892-3 (1955).

From the evidence presented it appears that collagen is the only protein discovered so far that contains hydroxylysine.

X-ray and infrared studies on carrageenin.
BAYLEY, S. T. *Biochim. et Biophys. Acta, 17,* 194-205 (1955).

X-ray diffraction patterns have been obtained from stretched fibers of whole carrageenin and its κ- and λ-components. The results establish structural differences between the 2 components, but the proposed fiber period in all 3 materials is 25.2 A. The κ-carrageenin in mol. is probably branched. In λ-carrageenin the fiber period may represent 3 disaccharide units the majority of which are composed of 2 sulfated D-galactose residues linked α—1, 3—. The long fiber period could be accounted for by a variation in the no. of sulfate groups attached to the galactose residues or by the presence of side residues.

Detection and identification of polyphenoloxidase in apple and pear skins.
SIEGELMAN, H. W. *Arch. Biochem. Biophys., 56,* 97-102 (1955).

A paper chromatographic technic for the detection and identification of substances susceptible to darkening with polyphenoloxidase is described. The principal browning substrate on chromatograms of the skin ext. from Grimes Golden and Golden Delicious apple and Bartlett pear was l-epicatechin. Bartlett pear also contained smaller amts. of d-catechin, another browning substrate.

Milk lipase. I. The lipolytic activity of separator slime.
NELSON, H. G., AND JEZESKI, J. J. *J. Dairy Sci., 38,* 479-86 (1955).

The work was undertaken to procure from separator slime highly concd. lipase prepns. in a phys. state that would provide ease of handling and a source of enzyme that would remain const. in concn. and other properties. By means of lyophilization it was possible to obtain the separator slime in a dry powder form which is sol. in H_2O, has high lipase activity and retains its lipolytic properties over a considerable length of time when stored at 0° C.

Cellulase and chitinase in soil amoeba.
TRACEY, M. V. *Nature, 175,* 815 (1955).

It is known that cellulose and chitin are broken down by many species of both bacteria and fungi that can be isolated from soil. It is probable that the soil fauna may also be important in this respect, for it is known that earth-worms and eel-worms may possess both cellulase and chitinase. Some soil amoeba were examd. to see whether they too, possessed these enzymes.

(Continued on page 20)

* These Selected Abstracts are made available to FOOD TECHNOLOGY through the cooperation of Dr. H. A. Campbell and the General Foods Corporation of White Plains, N. Y. The abbreviations found in these abstracts are similar to those used by Chemical Abstracts.

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Shelf Life of your finished products will be materially lengthened through the use of N. B. W. DRI-SEAL, the dry food flavor which remains fresh indefinitely.

DRI-SEAL is a process whereby millions of atomized flavor globules are hermetically sealed within a shell of edible gum.

No evaporation, oxidation, deterioration through contact with air, or cross blending with other product ingredients can occur as long as the product remains reasonably moisture free.

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SELECTED ABSTRACTS

(Continued from page 18)

Alterations in serum properdin levels following injection of zymosan.

PILLEMER, L., AND ROSS, O. A. *Science, 121,* 732-3 (1955).

Among the interesting properties listed for zymosan is that it can markedly influence the susceptibility to the effects of lethal doses of total-body irradiation when injected into mice.

BOTANY

Estrogenic activity in plant materials.

PIETERSE, P. *Dissertation Abstr., 15,* 659-60 (1955).

Exts. of pasture plants, hays, silages and other feedstuffs commonly used in the rations of domestic animals were assayed for estrogenic activity on oral administration. Red clover and alfalfa particularly showed significant activity.

MICROBIOLOGY

The effect of sorbic, propionic, and caproic acids on the growth of certain Clostridia.

HANSEN, J. D., AND APPLEMAN, M. D. *Food Research, 20,* 92-6 (1955).

These acids (0.12 and 1.0%) were found neither to inhibit nor to stimulate the growth of *C. botulinum* types A and B and *C. sporogenes.* Sorbic acid is recommended for anti-mycotic activity but not to prevent the growth of catalase negative organisms.

Microbiological process report—fungus proofing of paper and paper-board.

CRANDALL, H. C. *App. Microbiol., 3,* 89-94 (1955).

Requirements of effective mold proofing agents and methods for their application to paper are discussed. Although rapid tests would be extremely desirable, product use tests are the only reliable methods available.

NUTRITION

The relationship of carbohydrate metabolism to protein metabolism. IV. The effect of substituting fat for dietary carbohydrate.

THOMSON, W. S. T., AND MUNRO, H. N. *J. Nutrition, 56,* 139-50 (1955).

When fat is exchanged isocalorically for carbohydrate in the diet of the rat, urinary N output increases for a few days and then returns to its former level. Exchange of fat for carbohydrate in protein-contg. meals leads to a much greater increase in N output than occurs after a similar exchange in meals devoid of protein. Thus the main consequence of replacing the carbohydrate of a mixed diet by fat is a deterioration in the utilization of dietary protein. The change in N balance resulting from substitution of fat for carbohydrate is of similar magnitude, whether the fat is fed with the protein of the diet or apart from it. This indicates that the phenomenon is essentially due to removal of carbohydrate from the protein-contg. meal and not to an adverse effect of feeding fat with protein. There is a linear relationship between the amt. of carbohydrate fed along with the protein of the diet and the N balance of the rat.

Protein quality.

MELLANDER, O. *Nutrition Revs., 13,* 161-3 (1955).

The working hypothesis is that proteins are utilized partly as large peptides. Expl. evidence is given for the formation of such peptides, when certain milk proteins are enzymatically digested. It is probable that certain mixts. of proteins are less completely hydrolyzed than pure proteins. Large peptides as such may be of nutritional importance, because of the time factor in protein utilization and because they may combine with other nutrients, for example Ca and Fe, and favor their absorption. In the evaluation of vegetable protein combinations of high nutritional value to use as substitutes for animal proteins, it is possible that not only the amino acid content has to be taken into consideration, but also the type of peptides formed physiologically.

The digestion of proteins in vivo.

NASSET, E. S., SCHWARTZ, P., AND WEISS, H. V. *J. Nutrition, 56,* 83-94 (1955).

Dogs were fed protein-contg. and non-protein test meals and sacrificed approx. 1.5 hrs. later. The contents of the gastrointestinal tract were analyzed for total N, 70% EtOH-sol. N and 15 "free" amino acids. In the small intestine all 15 amino acids were present in approx. const. proportions whether protein or non-protein test meals were fed. It is concluded, therefore, that the qual. amino acid compn. of intestinal contents is not greatly altered by changing from a non-protein to a protein-contg. test meal.

Effect of prolonged antibiotic administration on the weight of healthy young males.

HAIGHT, T. H., AND PIERCE, W. E. *J. Nutrition, 56,* 151-61 (1955).

Six companies of Navy recruits were distributed at random into 1 of 3 "treatment" groups, and all subjects received once daily for 7 weeks one of the following identical-appearing prepns.: (1) Aureomycin, 250 mg.; (2) penicillin, buffered, oral procaine, 100,000 units; or (3) a placebo (calcium carbonate). Observations on the nude wt. and height were made initially and again 4 and 7 wks. later. Both the initial changes after 4 wks. and the total changes after 7 wks. revealed a distinct difference between the placebo group and the antibiotic group in wt. gain. The Aureomycin and penicillin groups were not significantly different.

Effects of malnutrition in early life on subsequent growth and reproduction of rats.

SCHULTZE, M. O. *J. Nutrition, 56,* 25-33 (1955).

Rats whose early growth had been severely inhibited by malnutrition during infancy were realimented after weaning by *ad libitum* feeding of a ration which supports good growth. The wt. increment of stunted young rats during the first 6 wks. of realimentation was about 80% of that attained by normal animals. During the second 6-wk. period of realimentation, the growth of male rats was severely retarded. After realimentation female rats whose growth had been retarded during infancy showed no impairment in their reproductive performance.

Studies on the availability of nitrogen from various ammoniated products for rumen bacteria and dairy cattle.

DAVIS, R. F., WASSERMAN, R. H., LOOSLI, J. K., AND GRIPPIN, C. H. *J. Dairy Sci., 38,* 677-87 (1955).

The results indicate that N from ammoniated products is not available to rumen bacteria or to the host to the same degree as is N from urea or from natural protein sources.

PHARMACOLOGY AND TOXICOLOGY

Toxicity of trichloroethylene-extracted soybean oil meal.

PICKEN, J. C., JACOBSEN, N. L., ALLEN, R. S., BIESTER, H. E., BENNETT, P. C., MCKINNEY, L. L., AND COWAN, J. C. *J. Agr. Food Chem., 3,* 420-4 (1955).

Soybeans, defatted soybeans, soybean protein, and casein were treated with the products resulting from the autoxidation of trichloroethylene in the attempt to produce typically toxic prepns. None of these products, assayed in the young calf, appeared capable of producing the typical toxicity diseases, though isolated manifestations of the disease syndrome developed. In further studies, the normal operation of a com. trichloroethylene-soybean extn. plant was altered in the attempt to produce conditions both favorable and unfavorable to possible autoxidative decompn. of trichloroethylene. Assay indicated that the meal toxicity was neither enhanced nor decreased by the modification.

Health hazards of drifting parathion dust cloud.

BRAID, P. E., WINDISH, J. P., AND ROSS, C. R. *Arch. Ind. Health, 11,* 403-7 (1955).

(Continued on page 24)

A for apple is the beginning of most primers. And apple is the first choice in flavor with most Americans, who enjoy an alphabet of apple dishes. To the distinguished family of Firmenich flavors, now enhancing many food products, is added that of Apple, captured by patient research and recreated by chemical skill. It is another Firmenich achievement, already welcomed by manufacturers who have added this popular flavor to their line of products; by others to improve those already established. Highly concentrated, stable, of the utmost fidelity and purity, Imitation Apple by Firmenich is offered with pride for your profitable use. Samples and technical data on request.

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SELECTED ABSTRACTS

FOOD AND FOOD TECHNOLOGY

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BARNETT'S Carotene **is**

SELECTED ABSTRACTS

(Continued from page 20)

Dusting of a vegetable crop was carried out with a com. insecticide consisting of 1% parathion in a diluent of attapulgus clay. The dust was applied at the rate of 40 lb./acre, and for wind speeds in the range 3 to 8 m.p.h. the following conditions were found: Parathion in the air at breathing height sufficient to constitute a respiratory hazard as far as 260 ft. from the dusting source.

Physiological properties of the saponifiable fraction of fish and whale oils.

Creac'h, P. *Oleagineux, 10,* 161 (1955); *Fette u. Seifen, 57,* 377 (1955).

While these fractions can be readily metabolized by humans, animals particularly chicks develop a metabolic imbalance, leading to an increase in the vitamin E requirements. Peroxide contg. oils are even more harmful while hydrogenated oils constitute an excellent feed stuff.

The fate of hydrocortisone in man.

Nutrition Revs., 13, 164-5 (1955).

Various studies have clearly pointed out the rapid conjugation or alteration of hydrocortisone given intravenously to man and the prompt excretion of metabolites in the urine. No evidence was obtained of its complete metabolism to CO_2.

Experimental methods used in determining chronic toxicity.

Barnes, J. M., and Denz, F. A. *Pharm. Revs., 6,* 191-242 (1954); *Biol. Abstr., 29,* No. 13835 (1955).

The methods used in testing safety of chemicals added to food are examd. critically. The conventional type of toxicity test is criticized because it is often an attempt to prove a neg. and large nos. of animals are necessary to derive results that are statistically significant. A more desirable approach is to obtain information on the fate and behavior of compds. after their introduction into the animal. Such work would lead logically to biochem. and physiological studies which are more scientific in contrast to the simple toxicity test.

PHYSIOLOGY AND MEDICINE

The mechanism of satiety: effect of glucagon on gastric hunger contractions in man.

Stunkard, A. J., Van Itallie, T. B., and Reis, B. B. *Proc. Soc. Exptl. Biol. Med., 89,* 258-61 (1955).

Administration of glucagon intravenously to 7 normal subjects resulted in prompt abolition of gastric hunger contractions on each of 16 occasions, and coincided with a rise in blood glucose levels and an increased peripheral capillary-venous glucose difference. Fall in blood glucose levels with decreasing capillary-venous differences was assocd. with a return of hunger contractions and intensification of the experience of hunger in 14 of the 16 occasions. Such a pattern may be a component of the normal satiety mechanism.

Effect of roentgen irradiation and other types of injurious agents on capillaries.

Rieser, P. *Proc. Soc. Exptl. Biol. Med., 89,* 39-41 (1955).

In the frog roentgen irradiation, heparin injection, trypsin and peptone shock increase the fragility of the capillaries. The fragility appears to be a consequence of a liberation of heparin into the circulation due to the irradiation or shock treatment.

Metabolism of intravenously-infused sorbitol.

Serberg, V. P., McQuarrie, E. B., and Secor, C. C. *Proc. Soc. Exptl. Biol. Med., 89,* 303-5 (1955).

Intravenous infusion of sorbitol in rabbits causes a prompt fructosemia which subsides relatively rapidly following cessation of infusion. A more variable secondary glucosemia occurs following the rise in blood fructose and during the subsidence of the fructosemia. Although rapidly metabolized, a small amt. of sorbitol appears in the urine with infusion rates as low as 0.33 g./kg./hr.

FOOD AND FOOD TECHNOLOGY

BAKING AND BAKERY PRODUCTS

Importance of "zwickelprotein" and "haftprotein" of wheat in baking.

Hess, K. *Kolloid Z., 141,* 61-82 (1955).

Protein adhering to the starch kernel (halfprotein) differs from the protein of the interkernel spaces (zwickelprotein) in I.E.P., x-ray diffraction pattern and colloidal properties; however, both are essential for satisfactory doughs. The "haftprotein" is strongly entrenched on the surface of the starch kernel and combines with the "zwickelprotein" during dough formation, thus providing for the best possible distribution of the starch between available protein. A sponge-like, lamellar (not a strand-like) structure is postulated for the bakery products examd.

CEREALS AND GRAINS

Studies on technics for reconstituting flours.

Walden, C. C., and McConnell, W. B. *Cereal Chem., 32,* 227-36 (1955).

This study was undertaken to devise a basic procedure for fractionation and recombination of flour with min. damage to baking strength.

FATS AND OILS

Autoxidation products of trichloroethylene.

McKinney, L. L., Uhling, E. H., and White, J. L. *J. Agr. Food Chem., 3,* 413-19 (1955).

The autoxidation with O at 45°-70° C. yielded about 95% of a liquid mixt. and about 5% of gaseous products. The liquid was composed of about equal parts of dichloroacetyl chloride and a very reactive isomer believed to be trichloroethylene epoxide. The gases consisted of phosgene, CO, and HCl in equimolar quantities. The highly reactive "epoxide" was found to yield chloral, dichloroacetyl chloride, glyoxylic and formic acids, and CO in the presence of Fe and moisture, which would be found in a soybean oil extn. plant.

INSECTICIDES

Flavor of Sebago potatoes grown in soil treated with chlordan, heptachlor, dieldrin, aldrin, or endrin.

Kirkpatrick, M. E., Linton, G. S., Mountjoy, B. M., and Albright, L. C. *J. Agr. Food Chem., 3,* 409-12 (1955).

Off-flavored products may result from unknown contamination of the soil, from a particular insecticide treatment-soil type-location combination, or a variation in the compn. of the insecticidal material, even though the same insecticide treatment causes no flavor defects under other environmental conditions.

SUGARS

Importance of relative vapor pressure as a guide to the behavior of sugars in storage.

Kelleher, J. *Intern. Sugar J., 57,* 36-8 (1955).

The relationship between the moisture and nonsucrose content of sugar although a useful means of ascertaining its liability to spoilage does not serve as a good criterion of keeping quality. A better criterion of the keeping quality of a sugar is its relative vapor pressure. This measurement represents an assessment of the combined effects of sucrose, H_2O, and the nonsucrose constituents on the capacity of the sugar for atm. moisture absorption. It will also indicate the relative osmotic pressure of the surface film on the sugar and hence the liability to microbial infection.

TEA

The chemical composition of tea.

McIlroy, R. J. *Food, 24,* 192-6 (1955).

Discussed are: seasonal variations in catechins, effect of plucking and pruning on catechin content, effect of manuring and shade on compn., influence of variety of tea bush, fractionation of the polyphenols of tea, formation of polyphenols in tea leaves, the volatile oil of tea, other odorous compds., components of the ether ext. of green tea, caffeine pigments, thiophyllin, sugars, pectin, crude-fiber, vitamins, amino acids and amides of tea leaf, and tea seed oil. 52 references.

(Continued on page 26)

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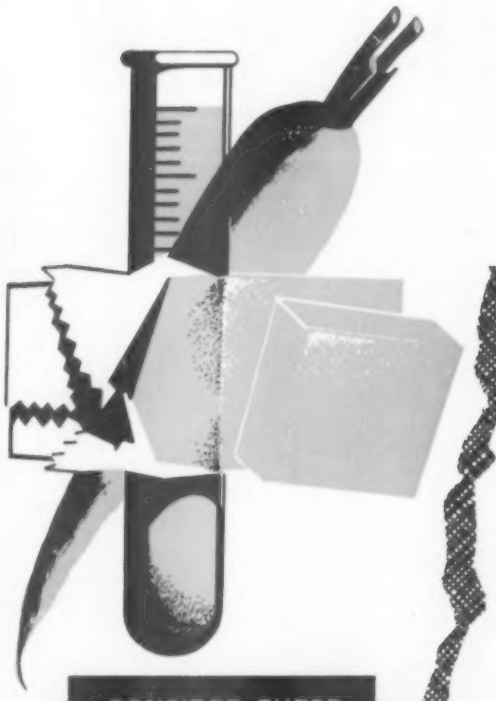

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SELECTED ABSTRACTS

(Continued from page 24)

ORGANIC CHEMISTRY

Derivatives of caffeic acid in sweet potato attacked by black rot.
URITANI, I., AND MIYANO, M. *Nature, 175,* 812 (1955).

Several polyphenols were found to be accumulated in the sound part next to the injured tissues of sweet potato attacked by black rot caused by *Ceratostomella fimbriata,* and chlorogenic acid, caffeic acid and isochlorogenic acid were isolated as well as the 2 kinds of new caffeic acid derivs.

PHYSICAL RESEARCH

Determination of the tensile strength of gels.
BEN-ARIE, M. M. *J. Polymer Sci., 17,* 179-90 (1955).

The method consists of extruding the gel vertically through a nozzle of diam. of 2-14 mm. and weighing the gel-column falling by its own wt. The wt. of the column divided by the area of the nozzle gives the value of the tensile strength. The functional dependence of the tensile strength on the extrusion velocity and the form of this function were established by a numerical approximation.

A graphic method for single-point determination of intrinsic viscosity.
HART, V. E. *J. Polymer Sci., 17,* 215-19 (1955).

For a given polymer-good-solvent system at a fixed temp., the product of intrinsic viscosity and concn. is a unique function of spec. viscosity alone up to high values of spec. viscosity. This permits a single parametric curve to be drawn from exptl. data; thereafter, accurate calcn. of intrinsic viscosity from the results of a single viscosity measurement becomes possible with the aid of a convenient equation.

Autophobic liquids and the properties of their adsorbed films.
HARE, E. F., AND ZISMAN, W. A. *J. Phys. Chem., 59,* 335-40 (1955).

This paper reports the results of an investigation of the wetting and spreading behavior on high energy surfaces of pure, lower-boiling acids, amines and alcs. (both branched and unbranched). It is shown that many of these compds. have the property of being "autophobic" or unable to spread on their own adsorbed films. Also it is proved that acids and alcs. which would be released by hydrolysis *"in situ"* of many of the esters discussed elsewhere, are capable of forming monolayers which would be imperfectly wetted by the parent ester.

RADIOCHEMICAL TECHNOLOGY

Radiation produces toxic substance.
Atomic Energy Newsletter, 13, 4, May 3, 1955.

Serum from a rat which had been exposed to x-rays was injected into unexposed adrenalectomized rats. Rats injected with serum from irradiated rats died sooner than those injected with serum from non-irradiated rats. This is an indication of a toxic substance in the serum of irradiated rats.

Radiation studies being made.
Atomic Energy Newsletter, 13, 4, May 3, 1955.

Q. M. Research and Development Board is sponsoring a study by the N. Y. State Agr. Expt. Sta. of the effect of ionizing radiation on fruit and vegetables.

MISCELLANEOUS INFORMATION

A taste panel study of the saccharin "off-taste."
HELGREN, F. J., LYNCH, M. J., AND KIRCHMEYER, F. J. *J. Am. Pharm. Assoc., Sci. Ed., 44,* 353-5 (1955).

Standard taste panel technics have been used to study the incidence of the off-taste of saccharin salt solns., freshly prepd. without heating. Evidence is presented to show that the off-taste of saccharin is intrinsic in the saccharin mol. as tasted by individuals who are sensitive to it. Decompn. products of trace impurities are not essential to the off-taste response. Approx. 25% of the population can be expected to detect the off-taste in saccharin concns. up to 0.026%, equiv. to about 10% sucrose.

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In Memoriam

It is with profound sorrow that we note the passing of Walter R. Gailey, long a member of the Institute, on May 26, 1955.

Walter R. Gailey was born in Philadelphia, Pennsylvania on June 2, 1890. His elementary education was obtained in Philadelphia and after a year's study at Cornell University, he came to Seattle, Washington. He entered the University of Washington in 1912 and graduated cum laude in Chemical Engineering in 1916. A year later, he was awarded the Master of Science degree from the same institution. After receiving his Master of Science degree, he worked for the Crescent Manufacturing Company for a year. He then served during the First World War as a munitions inspector. In 1919, he returned to the Crescent Manufacturing Company where he remained until his death.

He was a member of the Tau Beta Pi engineering honorary, Phi Lambda Upsilon, and Sigma Xi. He was a charter member of the Puget Sound Section of the American Chemical Society and a member of the National Organization since 1918.

Mr. Gailey was an active member of the Standards Committee and the Scientific Research Committee of the Flavoring Extract Manufacturers Association. In addition to these services, he was very active in promoting his profession and his company, by publishing papers and appearing before various groups as a speaker. Mr. Gailey is survied by his widow Zalia, his mother Mrs. Mathew Gailey, a son, Mr. Mike Gailey, a daughter, Mrs. Francis Wiseman, and a brother, Mr. I. H. Gailey.

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The Interplay of Science and Human Values in Food*

CHARLES GLEN KING, Ph.D., D.Sc.

Scientific Director of the Nutrition Foundation; and Professor of Chemistry, Columbia University

As a Charter Member of the Institute of Food Technologists, I am very grateful for the high honor of being selected to receive the Nicholas Appert Award. I would be deficient in a sense of humor and fairness, however, if I failed to recognize that the award is based chiefly upon the good work of loyal, competent, hard-working students and associates. The immense pleasure of just being a member of their respective teams in past years would alone make me their debtor—now I am doubly so.

I want also to express my appreciation for the trust shown by leaders in the food industry, in their steady and growing support of basic research and education through the Nutrition Foundation.

Having grown up on a farm in Washington, with a three-year sojourn in Kansas, and then having had the experience of working in the Washington Agricultural Experiment Station, so that I could eat and pay my bills while in college, biological and food chemistry was a natural choice of scientific interest.

Elements in the environment. My favorite nutrition experiments, however, have always been in the environment of a trout stream. The adjoining laboratory should be an open pine ridge where grouse are feeding.

Since fishing became restricted, I've learned to enjoy gardening, too, but last week I learned from a neighbor's experience not to take the latter too seriously. He had formed a circle of friends who increasingly took a justified pride in the use of Latin names for their plants. Then one of his semi-pro neighbors called along with a friend, so he sent his small son to show the guest through the garden while he talked shop with his neighbor. The guest inquired cordially of the lad what his name was, and received the friendly reply, "Tommy." Not knowing his family well, he then inquired, "And what is the rest of your name?" and received the faltering reply, "Well, I don't know my Latin name."

The interplay of science and human values in dealing with foods, gives to those who work in the related fields a special advantage. Seldom is basic research in nutrition or biological chemistry so far removed from pathways for human betterment that the scientist has any difficulty in sensing the significance of his work as a guide to new practices. Unfortunately, the budget director in some organizations may show a strange lack of imagination on this score. May I suggest that cultivation has value outside the garden.

In applied work, too, the same basic relationships are found—the human values are evident in terms of health, enjoyment of eating, convenience, economic advantages, and rising standards of living. Fortunately the scientist's family can be included in the rising standards of living when he does a good job. Manufacturers and distributors alike are increasingly regardful of the final effect of a product when it reaches the consumer. There is satisfaction, good judgment, and a promising outlook for the future in that kind of relationship.

A good beginning. The phenomenal success that has been achieved in the United States and Canada within the last 50 years, in developing food production, processing and distribution resources, should not blind us to the following situations:

(1) We have a great abundance of all the known essential nutrients, and a surplus to spare. Our diet as consumed by the public is the best it has ever been, and at the lowest equivalent cost in history. The so-called primitive diets in earlier history were tragically poor, by comparison. Within a few decades we have practically eliminated the former high incidence of rickets, scurvy, pellagra, and goiter—caused by deficiencies—and most of the diseases such as typhoid, diarrhea, undulant fever, and cholera, that once were spread to millions of our citizens by poor sanitation. Severe hunger is scarcely known. Every year, the infant death rate is lower, the length of life is extended, and children grow larger and faster. These great gains in health, convenience, enjoyment and economy should be interpreted to the public more vigorously and more clearly than has been accomplished to date. The striking advances accomplished by scientists working in and with the food industry should be understood by the public. Lay citizens would then be better protected from both sheer ignorance and the hazards of the diatribes of faddists and others who confuse and abuse them without let-up.

(2) But full recognition of past progress should not blind us to many remaining serious problems. As reported by the U. S. Public Health Service and by the Metropolitan Life Insurance Company, at least four of the six leading causes of death are of the chronic, metabolic types that are lessened in severity or prevented by good nutrition (heart disease, atherosclerosis and related vascular conditions, infant malformations, and diabetes). These chronic diseases are also high on the list of causes underlying deranged mental health. The social and economic penalty on society from this latter situation is already staggering but continues to increase. And tooth decay, though not a major cause of death, is a serious crippling nutritional disease that consumes about 20 per cent of our total expense for personal health and medical care.

(3) Our greatest specific nutrition problem is overweight. Yet it is clear, as pointed out especially by Dr. W. H. Sebrell, Jr., that the food industry as well as the public would benefit very greatly if over-weight were prevented. The man or woman who is over-weight today, dies more quickly in the days just ahead, so an

* Nicholas Appert Award address, given at the annual meeting of the Institute of Food Technologists, Columbus, Ohio, June 15, 1955.

adult customer is lost—if they ate less today, they would live so much longer that their total food consumption within the immediate years ahead would be greatly increased. They would also be healthier and have a greater earning and spending capacity.

(4) With reference to the metabolic diseases, one should keep in mind that the biochemical evidence available to the medical profession does not permit a clear picture of why over-weight and faulty diets are so damaging. Hence there is not a satisfactory basis for prevention, early diagnosis or efficient therapy.

Ideas open doors. The answers will come chiefly from basic research to discover what is in foods, what happens when the nutrients function inside the body, and what are the long-term effects of excesses, imbalances and deficiencies. With such information, the medical sciences will improve their service, and the food industry will be in a position to serve the public more reliably, more efficiently, and more profitably for everyone. Almost every year, new mineral elements, new vitamins, new amino acids and other useful food ingredients are discovered, and invariably the food industry makes use of these advances with resultant improved service and increased efficiency. Basic discoveries and the young trained scientists that usually come with them from strong university centers represent good investments, just as clearly as capital funds and physical equipment.

Early University of Pittsburgh work. The first area of graduate work that our group developed at the University of Pittsburgh started in 1924, with a systematic study of the detailed molecular structure and related properties of fats. Although progress always seemed slow, considerable progress was made in the study of isomeric monoglycerides, diglycerides, and triglycerides, x-ray studies of different crystal and amorphous forms, and the enzymes that split the esters to free fatty acids. Among the group were Herbert E. Robinson, B. F. Daubert, J. N. Roche, H. S. Averill, D. T. Jackson, D. Glick, B. F. Stimmell, H. H. R. Weber, F. A. Norris, O. E. McElroy, K. F. Mattil, F. L. Jackson, A. R. Baldwin, C. J. Spiegl, L. J. Filer, H. E. Longenecker, and a number of others. Nearly all have entered the food industry. The value of such work had to be taken largely on faith at that time. No one could foresee how important monoglycerides, diglycerides, known mixed triglycerides (*e.g.* the acetates) and isomeric crystal or amorphous forms, with exact knowledge of their melting points, x-ray patterns, solubilities and refractive indices were to become in controlling the properties of improved shortening and other edible fats. Neither could one foresee then how critical the hydrolysis of triglycerides would be in the stability of dehydrated foods and pre-mixed cereal products.

Vitamin C research. We started the search for vitamin C at the University in 1927. The primary objective was to train advanced students in biochemistry, but of course we knew that the vitamin was an essential nutrient for man, guinea pigs and monkeys, and hence might be of some use. The fact that it was characteristic of fresh foods of many kinds, but could be lost very easily, added interest to the search. Its habit of disappearing without notice, except at the end of a 100 day test with guinea pigs was occasionally disconcerting but not discouraging.

At this time, however, no one would have pictured the vitamin being used in the curing and protection of high quality meats, or in the protection of fruits and vegetables during processing, to say nothing of its being manufactured from corn sugar at the current rate of about 2 million pounds per year in the United States, with an estimated value of $16,000,000.

The synthetic product competes at some points with fresh food sources, but by and large, fresh, frozen and canned citrus fruits and juices and the major anti-scorbutic vegetables (fresh and processed) have risen steadily in consumption and public appreciation. Beyond its use in medical and pharmaceutical channels, the synthetic product undoubtedly has made an important contribution to the canning, dehydrating and frozen food industries, in terms of color, flavor, stability and nutritive quality.

There was a lot of drudgery in the work, especially during the first few years, when each student had to do the janitor work of cleaning cages, washing cups, and sweeping the floors in an animal room half a mile up a steep hill from the laboratory. The laboratory itself was beside my office on the seventh floor above the street level. The only suggestion of an elevator was an empty shaft beside the stairway—and the only reference to it that one could hear, was an occasional oath at the end of a long day, well embellished with tones of sulfur.

The starting group of three students, H. L. Sipple, D. P. Grettie and R. B. McKinnis, had as the only method of measuring vitamin C, a biological test based on feeding each of 50 guinea pigs by hand-pipette each day for about 100 days, followed by a detailed examination of the animals at autopsy for signs of scurvy. But the sixth student to undertake the search, William A. Waugh, had the satisfaction of isolating and identifying the crystalline product and seeing the old elaborate biological test for vitamin C replaced by a simple, rapid chemical titration during the school year 1931-32.

The chemical test was worked out chiefly by Waugh and Otto Bessey, and was based in part upon earlier work done by Tillmanns in Germany. The first help from outside the University had been a generous supply of good quality lemons from the Sunkist Growers. Then in 1932, Abbott Laboratories and Parke-Davis Company gave us substantial help in the form of a fellowship for Waugh and Bessey. Later E. G. White and A. Sigal were aided by these grants. Within a short time it was possible to estimate the vitamin content of a single drop of blood, and Dr. Glick succeeded in estimating the vitamin content of individual animal cells. Physiologic, genetic, and food processing research on the vitamin then moved ahead at a rapid pace.

Of course, others made important contributions, also, along the trail, but nearly all the work, until a method of analysis had been established, was done in academic institutions. E. C. Kendall gave us an independent sample of the vitamin prepared from adrenal glands, to confirm its identity, and E. K. Nelson promptly confirmed our published procedure for isolating the vita-

min from lemon juice. In doing so, he identified in one of our "inactive fractions," another vitamin, inositol. Dr. J. L. Svirbely who had completed his thesis along with Frederick Smith, just ahead of Waugh, demonstrated early in 1932 in A. Szent-Gyorgyi's laboratory in Hungary, that his product from adrenal glands, called hexuronic acid since 1929 had about the same vitamin C potency as ours.

A large part of our graduate student work dealt with vitamin C, after 1936 when we had the good fortune to receive supporting grants from the Buhl Foundation. For the first time, we could then get some simple equipment such as an electric refrigerator, a centrifuge, a Warburg-Barcroft apparatus and an Evelyn colorimeter.

Copper tie. Soon after studies of the function of vitamin C were under way by M. O. Schultze, E. H. Stotz, C. J. Harrer and E. Silverblatt, copper was discovered as the active catalyst in plant tissues and juices that caused oxidative destruction of ascorbic acid. This was a new concept for the function of copper. Kubowitz in Germany found the element copper in another plant enzyme during the same year. His product had different properties and served chiefly to oxidize phenols to quinones. The quinones, however, could oxidize ascorbic acid instantly, so two forms of copper were quickly associated with loss of the vitamin in plant sources. Both enzymes were later isolated and studied in detail by C. W. Dawson and his students at Columbia University. Collaboration with D. K. Tressler at Cornell University was of special interest and value in relation to retention of the vitamin during processing and storage.

Origin of the vitamin. C. V. Smythe, B. B. Drake, and C. Neubeck picked up early leads on the origin of ascorbic acid from sugar fragments, and related reactions with R-SH groups. During the past few years the group working with me at Columbia University has been especially interested in the origin and end products of ascorbic acid. By labeling glucose with radiocarbon in specific positions (C 1, 6, and 1-6), it was possible to prove direct synthesis of ascorbic acid from glucose, without cleavage of the carbon chain. Similar tests with glucuronic acid demonstrated that this acid also has its origin from glucose molecules, with the carbon remaining intact. Glucuronic acid was then found to serve as an intermediate compound in the conversion of glucose to ascorbic acid (E. H. Mosbach, J. J. Burns, S. S. Jackel, J. F. Douglas, H. H. Horowitz, H. B. Burch).

Among the end products of ascorbic acid in rats and guinea pigs, only carbon dioxide, oxalic acid and a small yield of glycogen have been isolated thus far. It was of some interest to label oxalic acid with radiocarbon, and to find that the acid shows practically zero oxidation or change of any kind, after it is formed in the animal body (C. O'H. Curtin).

One of the most surprising results was to find that the vitamin regulated the rate of forming and using cholesterol in the animal body (L. L. Solomon, R. R. Becker, T. A. Venkitasubramanian).

The question of whether embryonic and infant tissue could synthesize ascorbic acid, as often claimed by a group of French investigators was clearly decided in the negative. Labeled glucose administered to embryonic guinea pigs did not result in even traces of radiocarbon being introduced into the ascorbic acid held in their tissues. This clear result was of immediate practical importance because of the misleading claims repeated through a period of 20 years, stating that there was little or no need for feeding vitamin C to small babies.

Human requirement. An important part of our work on vitamin C since its identification has been to get an estimate of the human requirement. This problem has many ramifications in the food industry as well as in medicine and public health. Among the early tests, we found that an adult with scurvy required about 4 to 5 grams of the vitamin to restore his normal body reserves. A later series of direct analyses then showed that the tissues of a well-nourished adult actually contained about 5 grams of the vitamin.

A study of the vitamin C content of human milk showed that an infant nursed by a well-nourished mother is furnished with about 25 to 50 mg. of the vitamin per day, depending, of course, upon the amount of milk consumed. Then by systematic studies of blood serum, blood cell and urine concentrations in parallel with known intakes, it was evident that an intake in the range of 70 mg. per day for an adult was necessary to maintain tissue concentrations that are regarded by American investigators as satisfactory (R. R. Musulin, M. Yavorsky, C. M. Lyman, I. Selleg, P. Almaden, W. F. Swanson, M. L. Menten). Some groups, especially in England, are of the opinion that lesser quantities are adequate. The British showed in a well-organized test with volunteer subjects that roughly 10 mg. per day would protect from scurvy when young adults were carefully sheltered, under hospital-like conditions, but that index is not regarded as a satisfactory guide for optimum nutrition. There are several kinds of substantial and independent evidence to support the approximate recommendations of the National Research Council.

In recent studies of irradiation effects from Cobalt-60 upon vitamin C in foods and in pure solutions, at Columbia University, we were interested to find an excellent correlation between oxidation of the vitamin and the oxidation of ferrous ion, in the presence of molecular oxygen. In this case, at least, a simple ferrous dosimeter furnishes an accurate measure of the effect upon a sensitive vitamin. Since the test is both sensitive and accurate, it offers promise of furnishing a guide to more complex changes such as those responsible for deterioration in flavor, odor, and color, and the destruction of other nutrients (N. F. Barr, E. L. Gaden, H. C. Kung).

CONCLUSION

From the kind of experiences outlined above, and from observations on the far greater progress made possible by others, I feel confident in suggesting that those of us who have found opportunities to work in this field of foods and nutrition are fortunate. Whether engaged in basic research or in work directed toward immediate practical applications, there is both excitement and satisfaction in seeing one's work move ahead. To paraphrase a very wise adviser of freshmen at Har-

vard University, "if we make no progress, it is not elbow room that we need, but more likely, 'elbow grease' —it is energy to support worthy ideals."

To build perspective and appreciation among those who take too much for granted about foods and nutrition, there should be an opportunity to see and study some of the less fortunate parts of the world—as in large sections of Latin America, Africa and India. For example, find answers to your questions when you see millions of rural and village folk in large sections of Central America, with a standard diet imposed on children at weaning time that is limited to boiled beans and corn. One can then appreciate a generous supply of safe milk, eggs, meat, clean vegetables and other foods to combine with cereals and fruits to build a perfect diet—in contrast with seeing half of the children die before reaching five years of age, and half of those who die in hospital wards too malnourished to survive even when fed and given medical care. Then note that among those who survive beyond age five, most children are permanently stunted in growth by two or three years. You become at least a little more worldly-minded, and besides, you tend to look at your own child and your neighbor's child with more respect for what they eat.

Sorbic Acid as a Fungistatic Agent at Different pH Levels for Molds Isolated from Strawberries and Tomatoes[a]

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Data on the effectiveness of sorbic acid in controlling growth of various fungi isolated from tomato and strawberry fruits is provided. Among those studied and shown to be benefited were Aspergillus, Alternaria, Botrytis, Rhizopus, Colletotrichum, Fusarium, and Rhizoctonia.

Through the development of better packaging protection for meats, cheese, bakery products, fruits and other produce, the control of molds in foods has become more important as the interiors of the packages have a higher relative humidity, which is ideal for mold growth. Fresh strawberries, cherries, raspberries, peaches and other soft, fleshy fruits are especially susceptible to invasion of rot producing fungi. A way to keep these fruits in better condition for a longer period of time on the fresh fruit market would be of considerable value.

Ten years ago Gooding *(1)* described a process for inhibiting growth of fungi in or on food products and food wrappers. The addition of sorbic acid, one of the unsaturated fatty acids, to food products was found to be effective in control of fungus growth. At the present time the Food and Drug Administration has allowed sorbic acid to be used as a fungistatic agent in place of sodium benzoate in food products such as orange juice, fruit and fruit syrups, pickles, margaraine and candies. Smith and Rollin *(4)* found this fungistatic agent to be markedly superior to sodium benzoate in protecting cheeses and cheese products. They reported that 0.05% sorbic acid mixed with American cheese was sufficient to inhibit mold development. Phillips and Mundt *(3)* reported on the value of using asorbic acid to inhibit yeast and mold growth while permitting normal fermentation in curing of cucumbers.

Penicillium roquefortii and mixed (unidentified) molds were used by Melnick, Luckman, and Gooding *(2)* to show some of these were responsible for metabolic oxidation of the sorbic acid that had migrated from treated wrappers into cheese, resulting in reduction in amount of sorbic acid present. However, very meager information is available on the effectiveness of sorbic acid in controlling growth of specific fungi.

EXPERIMENTAL

Representative genera were selected from the numerous fungi isolated from strawberry and tomato fruits. These fungi are the most frequent causes of rot in the above mentioned fruits and would be the most important ones encountered when mold counts of the fruits are determined by the Howard Mold Count method.

Two organisms, *Colletotrichum phomoides* and *Fusarium* sp., were selected to test the effectiveness of sorbic acid as a fungistatic agent in a liquid glucose peptone medium. The medium contained 10 g. of peptone and 40 g. of glucose per one liter of distilled water. Various concentrations of sorbic acid including 0.01%, 0.025%, 0.050%, 0.075%, and 0.10% were added to portions of the medium, and the medium was adjusted to pH 3, 5, and 7. After sterilization the pH was checked again before inoculating the various fungi into the liquid medium in the plates. After inoculation of the medium in triplicates, observation of any growth that occurred was noted at the end of 7 days and 14 days.

The second series of tests on the fungistatic activity of sorbic acid was run against molds isolated from strawberry fruits. Frozen, packaged strawberries were thawed and put through a pulper to produce a puree. A portion of the puree was left at a pH of 3.3 while the other portion was adjusted to a pH of 4. Control samples at these two different pH levels were retained

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while the three remaining portions of the strawberry medium had sorbic acid added at concentrations of 0.025%, 0.050% and 0.075% respectively. After sterilization for 15 minutes the pH was rechecked. The plates with no sorbic acid, 0.025%, 0.050% and 0.075% sorbic acid were inoculated in triplicate. These were checked for mold growth at the end of 7 and 14 days.

The third series of tests was set up in a similar manner to the second series, utilizing tomato juice in place of strawberry puree as the medium. Fungi commonly causing decay in tomato fruits were selected for inoculation into the medium. Commercially canned tomato juice with an adjusted pH of 4.4 was used as the medium. Prior to sterilization, sorbic acid in concentrations of 0.025%, 0.050%, and 0.075% was added to the tomato juice. The plates with different concentrations of sorbic acid were inoculated with the various fungi isolated from tomato fruits. At the end of 7 and 14 days the controls and the plates with sorbic acid were examined for mold growth.

RESULTS

The results in Table 1 show that *Colletotrichum phomoides* and *Fusarium* sp. grew in all cases in the liquid glucose peptone medium at a pH of 3, 5, and 7. When sorbic acid in concentrations of 0.01%, 0.025%, 0.050%, 0.075%, and 0.10% was added to the medium at a pH of 3, no fungus growth occurred at the end of 7 or 14 days. However, when the pH of the medium was 5, both *C. phomoides* and *Fusarium* sp. grew when the medium contained 0.010% and 0.025% sorbic acid. Higher concentrations of sorbic acid inhibited the fungi for a 14 day period. A distinct change was noted in the effectiveness of sorbic acid when the pH of the medium was raised up to 7. No inhibition of growth of these fungi occurred at any of the concentrations of sorbic acid employed.

When strawberry puree was used as the test medium, sorbic acid in a concentration of 0.050% controlled all mold growth at a pH of 3.3 as can be seen in Table 2. When the pH was at 4, two isolates of *Pennicillium* and three isolated of *Aspergillus* showed a slight amount of growth in 0.050% sorbic acid concentration in the medium. All mold growth was inhibited at a concentration of 0.075% for both media at pH 3.3 and 4. However, when sorbic acid concentration was at 0.025%, certain genera—*Aspergillus, Penicillium,* and *Alternaria* were able to grow at a pH of 3.3. Other genera were inhibited under these conditions. When the pH was 4, one other genus, *Dendrophoma,* also showed growth.

In the third series of tests with tomato juice as the medium, similar effectiveness of sorbic acid in controlling the growth of different groups of fungi was apparent as shown in Table 3. In all cases, a concentration of 0.075% sorbic acid in sterile tomato juice controlled mold growth. In one case a slight amount of growth occurred for one strain of *Aspergillus* when the concentration of sorbic acid was lowered to 0.050%. When a concentration of 0.025% was used, only two isolates of *Aspergillus,* two isolates of *Mucor,* one strain of *Colletotrichum,* and one strain of *Oospora* showed growth while all other genera were inhibited. In all cases the controls containing tomato juice without sorbic acid had mold growth.

TABLE 1

Sorbic acid at various concentrations in a liquid glucose peptone medium at different ranges in pH

Fungus	pH	Concentration of sorbic acid					
		Control	0.010%	0.025%	0.050%	0.075%	0.10%
Colletotrichum phomoides	3	+	−	−	−	−	−
	5	+	+	+	−	−	−
	7	+	+	+	+	+	+
Fusarium sp.	3	+	−	−	−	−	−
	5	+	+	+	−	−	−
	7	+	+	+	+	+	+

+ = Growth at end of 7 days
− = No growth at end of 7 days

DISCUSSION

The tomato medium at a pH of 4.4 had almost no fungus growth except for a slight amount of growth for one strain of *Aspergillus* when sorbic acid was added at a concentration of 0.050%. In contrast, strawberry puree with 0.050% sorbic acid supported the growth of three genera, *Penicillium, Aspergillus* and *Alternaria* at a pH of 3.3, but stopped the growth of *Alternaria* at a pH of 4. Thus, it appears that there is more effective control of mold growth at a lower concentration of sorbic acid in tomato juice.

The application of sorbic acid on fresh fruits or in packaged fruits may be of value especially under conditions of high humidity. The results in Table 2 and 3 show that some of the more important fungi that ac-

TABLE 2

Sorbic acid at various concentrations in a strawberry medium at a pH of 3.3 and 4

Fungus (Isolate No. in parentheses)	Control at pH 3.3 & 4	pH 3.3			pH 4		
		Concentration of sorbic acid			Concentration of sorbic acid		
		0.025%	0.050%	0.075%	0.025%	0.050%	0.075%
Alternaria sp. (21)	+	+	−	−	+	−	−
Alternaria sp. (13)	+	−	−	−	−	−	−
Aspergillus niger (15)	+	+	−	−	+	+ (slight)	−
Aspergillus flavus (599)	+	+	−	−	+	+ (slight)	−
Aspergillus (54)	+	−	−	−	+	−	−
Aspergillus sp. (54)	+	−	−	−	+	+	−
Botrytis cinerea (14B)	+	−	−	−	−	−	−
Dendrophoma obscurans (50)	+	−	−	−	+	−	−
Fusarium sp. (10)	+	−	−	−	−	−	−
Hormodendron sp. (4D)	+	−	−	−	−	−	−
Hormodendron (11)	+	−	−	−	−	−	−
Monilia sp.	+	−	−	−	−	−	−
Pezizella lythri (48)	+	−	−	−	−	−	−
Mucor sp. (83)	+	−	−	−	−	−	−
Mucor sp. (73)	+	−	−	−	−	−	−
Oospora sp. (106)	+	−	−	−	−	−	−
Penicillium sp. (9B)	+	+	−	−	+	+ (slight)	−
Penicillium sp. (8E)	+	+	−	−	+	+ (slight)	−
Pullularia pullulans (71)	+	−	−	−	−	−	−
Rhizopus nigricans (157)	+	−	−	−	−	−	−
Rhizopus nigricans (149)	+	−	−	−	−	−	−

+ = Growth at end of 7 days
− = No growth at end of 7 days

TABLE 3
Sorbic acid at various concentrations in tomato juice at a pH of 4.4

Fungus (Isolate No. in parentheses)	Control	Concentration of sorbic acid		
		0.025%	0.050%	0.075%
Aspergillus sp. (21)	+	−	−	−
Aspergillus niger (23)	+	+ (slight)	−	−
Aspergillus sp. (20)	+	+	+ (slight)	−
Aspergillus sp. (125)	+	−	−	−
Colletotrichum phomoides (40)	+	−	−	−
Colletotrichum phomoides (44)	+	−	−	−
Colletotrichum phomoides (45)	+	+ (slight)	−	−
Fusarium sp. (152)	+	−	−	−
Fusarium sp. (56)	+	−	−	−
Fusarium sp. (65)	+	−	−	−
Mucor sp. (80)	+	−	−	−
Mucor sp. (81)	+	−	−	−
Mucor sp. (87)	+	+	−	−
Mucor sp. (78)	+	+	−	−
Oospora sp. (107)	+	+	−	−
Oospora sp. (105)	+	−	−	−
Oospora sp. (94)	+	−	−	−
Penicillium sp. (112)	+	−	−	−
Penicillium sp. (120)	+	−	−	−
Penicillium sp. (115)	+	−	−	−
Penicillium sp. (110)	+	−	−	−
Rhizoctonia solani (143)	+	−	−	−
Rhizoctonia solani (132)	+	−	−	−
Rhizoctonia solani (141)	+	−	−	−
Rhizopus nigricans (162)	+	−	−	−
Rhizopus nigricans (159)	+	−	−	−
Rhizopus nigricans (160)	+	−	−	−

+ = Growth at end of 7 days
− = No growth at end of 7 days

count for most of the rot of the strawberry fruits and tomato fruits are inhibited at the lowest concentrations used in these experiments. The more important causes of rot and high mold counts in strawberry fruits are *Rhizopus* and *Botrytis*. Both of these molds are inhibited by sorbic acid at a concentration of 0.025%. This is also true in the case of the more important rot producing fungi in tomatoes such as *Colletotrichum*, *Fusarium*, *Rhizopus*, and *Rhizoctonia*. Further research in this direction may show the value of using this compound on the soft fresh fruits before they are brought into the commercial markets, especially in humid weather. Of interest is the finding that sorbic acid was capable of inhibiting the growth of all the test fungi when added in 0.075% concentration to media containing either the strawberry puree or the tomato juice at a pH natural to these products.

SUMMARY

Various fungi isolated from tomato and strawberry fruits were placed in a glucose peptone medium with concentrations of sorbic acid ranging from 0.01% to 0.10% at pH 3, 5, and 7. These same fungi were also seeded in strawberry puree at a pH of 3.3 and 4.0 with concentrations of sorbic acid of 0.025%, 0.050% and 0.075%. Some strains of *Penicillium*, *Alternaria*, and *Aspergillus* showed slight growth at a pH of 4 in 0.050% sorbic acid.

When tomato juice was used as the medium, all fungi except one strain of *Aspergillus* was inhibited at a pH of 4.4 in 0.050% sorbic acid. When 0.075% sorbic acid was added to the various media, no growth of the fungi occurred. Likewise 0.075% sorbic acid inhibited the growth of all test fungi when added to strawberry puree or tomato juice at a pH natural to these products.

The more important fungi causing rot in strawberry fruits, *Botrytis* and *Rhizopus*, were inhibited when 0.025% sorbic acid was put in the strawberry puree. A number of the more important fungi causing rot in tomato fruits such as *Colletotrichum*, *Fusarium*, *Rhizopus*, and *Rhizoctonia* were also inhibited in the tomato juice by 0.025% sorbic acid.

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Evaluation of Thresholds and Minimum Difference Concentrations for Various Constituents of Wines. IV. Detectable Differences in Wine.

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Threshold and minimum difference concentrations for various major component substances of wine have been determined in aqueous solution and reported earlier *(5, 6)*. To gain insight into the more complex situation that obtains in wine itself, a study was made of the effect of combinations of substances upon liminal and minimum detectable difference concentrations in water solution.

The constituents of wine are too numerous to mention in this paper; research and a review of the literature has been ably performed by Amerine *(1)*. In the present investigations, only those substances were studied which (a) are present in wine in more than nominal amounts and (b) are known to produce organoleptic sensation.

The object of this paper is to correlate the previous studies with the determinations made in wine. There is a relationship between chemical composition and the quality of wine. In fact, organoleptic ratings of 13 Cabernet and 17 Riesling wines were found to be dependent upon certain constituents, even though the tasters appeared to vary in skill *(3)*. Also, by factor analysis, Baker *(4)* was able to demonstrate the dependence of a quality factor upon certain variables in the wines tasted. It is necessary, therefore, to determine the detectable concentration differences for substances in wine causing sensory stimulation in order to define boundary conditions for quality.

EXPERIMENTAL METHODS AND MATERIALS

The triangular test technique *(8)* was used throughout with methodological modifications previously described *(5)*. A panel of 12-16 members was employed, tasting daily, to determine the detectable concentration differences.

For the tests, a white and a red table wine were used. The analysis of each wine is shown in Table 1. The methods of analysis were those of the Association of Official Agricultural Chemists *(2)*.

TABLE 1
Chemical analyses of white and red table wines

	White	Red
Alcohol % by volume	11.0	12.0
Total acidity g./100 ml.	0.74	0.64
Tannin g./100 ml.	0.02	0.20
Extract g./100 ml.	2.24	2.50
Reducing sugar g./100 ml.	0.15	0.18
Free tartaric acid g./100 ml.	0.12	0.14
Potassium bitartrate g./100 ml.	0.49	0.30
Glycerol g./100 ml.	0.30	0.80
Sulfur dioxide total p.p.m.	52.	32.
Sulfur dioxide free p.p.m.	14.	2.
Volatile neutral esters (as ethyl acetate) p.p.m.	212.	308.
pH	3.3	3.4

The glycerol, tartaric acid and ethyl acetate used in the tests were of reagent grade. The ethyl alcohol was a triple-distilled neutral grape spirit of 95.5% alcohol by volume, the tannin was an Australian grape seed tannin, and the sucrose was granulated cane sugar. Acetaldehyde was repurified by fractional distillation and then diluted to 5 g. per 100 ml. in water to prevent polymerization. Sulfur dioxide gas was bubbled into distilled water to make a stock solution of 2%.

RESULTS AND DISCUSSION

Detectable concentration differences were determined for sucrose at the 0, 1, 5, and 10 g. per 100 ml. concentration levels, using both the white and red table wines as test media (Table 2). The detectable concentration differences for sucrose in all concentrations used showed no significant differences between the white and the red table wine. The detectable differences in wine were much greater than for sucrose in water, as determined previously *(6)*, but were comparable to results obtained when sucrose was tested in an aqueous solution containing 10% ethyl alcohol by volume and 0.60 g. per 100 ml. total acidity, and also in solutions containing tannin. Ethyl alcohol and tannin appear to be major contributors to the increase in the minimum detectable differences for sugar in wine.

TABLE 2
Detectable concentration differences for sucrose in white and red table wine

Initial sucrose level (g./100 ml.)	Minimum detectable sucrose increment in:	
	White	Red
0	0.9 g./100 ml.	0.8 g./100 ml.
1	0.8 g./100 ml.	0.7 g./100 ml.
5	1.1 g./100 ml.	1.0 g./100 ml.
10	1.7 g./100 ml.	1.6 g./100 ml.

Table 3 gives results of other substances tested in the 2 wines. The detectable difference in concentration for alcohol was identical for both wines, 4.0% by volume, and the presence of sugar in varying amounts did not affect the value in the red table wine, the only wine tested in this manner. In aqueous solutions containing 10% alcohol by volume, detectable differences for alcohol were noted as 2.0% at the zero sugar level and 4.0% at a sugar concentration of 10 g. per 100 ml. *(7)*.

The detectable difference concentration for sulfur dioxide varied with the wine tested; 100 p.p.m. (58 p.p.m. free) was required for the red table wine and 207 p.p.m. (120 p.p.m. free) for the white wine. Since this was an odor factor primarily, the difference in bouquet between the 2 wines may have been the cause

for the discrepancy. In water solution, 40 p.p.m. free sulfur dioxide could be separated significantly from 20 p.p.m. *(5)*.

The sensation of glycerol contributes to both sweetness and body in the wine. The presence of added glycerol was somewhat more difficult to detect in red than in white table wine; 1.3 g. per 100 ml. was detectable in the red and 0.9 g. per 100 ml. in the white

TABLE 3
Detectable concentration differences for various substances in wine

	Minimum detectable concentration increment in:	
	White	Red
Ethyl alcohol % by vol.		
With added sucrose		
0 g./100 ml.	4.0	4.0
5 g./100 ml.		4.0
10 g./100 ml.		4.0
Sulfur dioxide p.p.m.		
Total	207.	100.
Free	120.	58.
Glycerol g./100 ml.	0.9	1.3
Tannin g./100 ml.		
With added sucrose		
0 g./100 ml.	0.10	0.15
5 g./100 ml.		0.15
10 g./100 ml.		0.15
Ethyl acetate p.p.m.	175.	200.
Acetaldehyde p.p.m.	125.	100.
Tartaric acid g./100 ml.		
With added sucrose		
0 g./100 ml.	0.15	
1 g./100 ml.	0.15	

wine. The original wines contained 0.8 and 0.3 g. per 100 ml. for the red and white wine, respectively, and this difference in initial glycerol content may account for the discrepancy in the added amounts that were just detectable as differences. In aqueous solution, glycerol was detectable at a concentration of 0.38 g. per 100 ml. *(5)*. However, in the presence of organic acids and alcohol, threshold concentrations for aqueous solutions approached those for the wines *(7)*.

Ethyl acetate and acetaldehyde gave only odor sensations in the concentrations used, and no significant difference was noted between the white and red table wine when the difference concentrations were determined. A difference of 175 p.p.m. ethyl acetate was discernible in the white wine and 200 p.p.m. in the red wine. In the case of acetaldehyde, 125 p.p.m. was detectable when added to the white and 100 p.p.m. when added to the red wine.

An addition of 0.15 g. per 100 ml. of tartaric acid was necessary for the difference in acidity to be detected in white wine. In aqueous solution, 0.30 g. per 100 ml. of tartaric acid could barely be distinguished from 0.25 g. per 100 ml. *(5)*. In solutions containing a mixture of organic acids the detectable differences were 0.05 and 0.10 g. per 100 ml. for solutions assaying 0.30 and 0.60 g. per 100 ml. total acidity (calculated as tartaric acid), respectively *(7)*.

Variations in tannin concentration were difficult to determine due to its astringency, a characteristic which caused a carry-over in sensation from sample to sample as each was tasted. In red table wine 0.15 g. per 100 ml. added tannin was detectable, and in white wine, 0.10 g. per 100 ml. In water, 0.02 g. per 100 ml. could be detected *(5)*.

SUMMARY

Minimum detectable concentration differences were determined for sucrose, ethyl alcohol, sulfur dioxide, glycerol, tannin, ethyl acetate, acetaldehyde and tartaric acid in both a white and a red table wine.

For sucrose, the minimum difference concentration depended upon the sugar concentration level, but there was no significant difference between the two wines. The minimum detectable glycerol concentration was somewhat higher in red wine than in white wine.

In the two wines, a difference of 0.15 g. per 100 ml. tannin was detectable in the red and 0.10 g. per 100 ml. in the white.

To be detectable in white wine, a difference of at least 0.15 g. per 100 ml. tartaric acid was necessary.

There was a difference between the white and red table wines for detectable difference in concentration of sulfur dioxide, but there was no significant difference between the two wines when determinations were made for detectable differences of ethyl acetate or acetaldehyde.

The minimum concentration differences for the above substances in wine were found to be higher than those in aqueous solution.

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The Effect of Storage on the Composition and Nutritive Properties of Farm-Style Hams[a]

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The results obtained in an investigation of the composition, nutritive value and keeping quality of hams dry cured with salt only are presented. The hams were cured and smoked and then stored at 40°, 70°, and 90° F., for 6 weeks, and 6 and 12 month periods. Data obtained on weight losses, chemical constituents, nitrogen efficiency value, vitamin content, palatability, and bacteriological flora are discussed.

The present article, one of a series *(4, 5, 6, 14)*, deals further with the relation of processing to the quality of cured hams. Approximately 2 billion pounds of meat are used annually by farmers, much of which is cured or otherwise processed on the farm.

Although there is some scattered information *(2, 8, 10, 12)* available regarding farm curing methods and ham composition, more complete data are needed on the composition and the effect of aging of farm-style hams. As previously reported *(4)*, 74% of farmers who cure meat employ dry curing without pumping. Approximately one-half of this group use only salt as a curing agent. Experiments herein reported were conducted to obtain information on this type of unpumped dry salt-cured ham.

In the present work, this commonly practiced method of dry-curing hams with salt only, was duplicated under controlled experimental conditions using meats from animals of known history and feeding. Samples were analyzed to determine chemical composition, nitrogen efficiency value, vitamin content, palatability, and bacterial content. Following publication of the present paper on hams dry-cured with salt only, a later paper is planned to present data obtained on other methods of farm curing. Information obtained from these studies provides a basis for modifying methods to effect improvement in the quality of farm cured hams.

EXPERIMENTAL

One hundred and eight hams selected for the study were obtained from hogs of known history ("Record-of-Performance"), all receiving the same type of feed. The trimmed hams, prior to curing, averaged 15 pounds, 9 ounces; ± 15 ounces. The hams were thoroughly rubbed with table salt, using 4 pounds per 100 pounds of meat, and stored overnight at 38° F. (3.3° C.). They were again rubbed, using 6 pounds salt per 100 pounds of meat, and placed skin side down in wooden bins perforated to allow drainage. Since only a relatively small amount of salt adhered to the meat after rubbing, the remainder was carefully packed around the hams, particularly on the lean exposed surfaces and bone areas. The hams were cured for approximately 23 days (1½ days per lb.) at 38° F. (3.3° C.). When the curing was completed, the hams were spray-washed for 3 minutes in water at 110° F. (43.3° C. to remove surface salt, hung up to dry, and then smoked 42 hours (6 hours daily) in hickory smoke at 150° F. (65.6° C.) to an internal temperature of 125°-130° F. (51.7°-54.4° C.). The hams were refrigerated at 38° F. (3.3° C.) after each daily 6-hour period of smoking. The average weight of these smoked hams was 13 pounds, 12 ounces; ± 14 ounces.

The smoked hams were then divided into 3 lots for storage at 40°, 70°, and 90° F. (4.4°, 21.1°, and 32.2° C.). Samples were withdrawn for analyses after 6 weeks, and 6 to 12 months. During storage, the temperatures of the hams were determined with thermocouples inserted into the center of the meat. Temperatures were recorded on strip charts with two 16-point automatic potentiometers. The average relative humidities during storage at 40°, 70°, and 90° F. (4.4°, 21.1°, and 32.2° C.) were, respectively, 90, 75, and 55%. Weights of the fresh, cured, smoked, and stored hams were obtained as a basis for calculating losses in processing and storage. The conditions used in storing the hams were for experimental evaluation, storage at the constant temperatures of 70° and 90° F. (21.1° and 32.2° C.) being more drastic than actual farm practice, but useful to accelerate aging processes.

Table 1 shows the changes in weight, in terms of both pounds and percentages, that occurred in 97 hams during processing and storage. Losses of weight were of course mainly caused by evaporation of moisture. The loss of 2.6% which occurred during curing, was followed by a further loss during smoking, resulting in a total processing loss of 11.5%. The data show that on storage, loss of moisture due to temperature and humidity differences occurred more slowly at 40° F. (4.4° C.) than at 70° F. (21.1° C.) or 90° F. (32.2° C.). After 12 months' storage, moisture losses at 70° and 90° F. (21.1° and 32.2° C.) were respectively only 2.5 and 1.9% more than after 6 months' storage.

TABLE 1

Average weights of farm cured hams at different stages of processing and storage

Description of hams	Storage[1] conditions	No. of hams	Weight	Weight in relation to fresh weight
			lb.	%
Fresh	.....	97	15.6	100.0
Cured	.....	97	15.2	97.4
Cured and smoked	.....	97	13.8	88.5
Stored	6 wks., 40° F.	15	13.1	84.0
	6 wks., 70° F.	16	12.8	82.1
	6 wks., 90° F.	17	12.5	80.1
	6 mos., 40° F.	5	12.7	81.4
	6 mos., 70° F.	10	12.0	76.9
	6 mos., 90° F.	6	11.4	73.1
	12 mos., 40° F.	6	12.0	76.9
	12 mos., 70° F.	7	11.6	74.4
	12 mos., 90° F.	8	11.1	71.2

[1] Relative humidities at 40°, 70°, and 90° F., were 90, 75 and 55%, respectively.

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CHEMICAL COMPOSITION

Proximate composition, soluble nitrogen, nonprotein nitrogen, free fatty acids, peroxide value, sodium chloride, and pH were determined on representative samples from 21 cured and stored hams and 5 fresh hams, using the methods of analysis described in a previous paper *(6)*. Chlorides are reported in terms of percentage of sodium chloride. Results for nitrogen were calculated as percentage of total nitrogen. The percentage of free fatty acids was expressed as oleic acid content of the fat and the peroxide value as milliequivalents per 1000 g. of fat. The average results of the analyses are shown in Table 2. Variation in salt content was subjected to statistical analysis. In these calculations, the salt content of all the stored cured and smoked hams was adjusted to that which would be present if the hams contained 65.1% moisture, this being the moisture content of the hams prior to storage. After making these adjustments, the mean salt content was found to be 4.39% with a standard deviation of ± 0.91%. The relatively large standard deviation indicates that these dry-cured hams varied considerably with respect to salt content. Based on this fact, it appears that study is needed to develop a curing technique which produces hams of less variable salt content.

As shown in Table 2, the protein, fat, ash, and sodium chloride content of the hams increased to the degree that the hams became dehydrated during storage. To aid in the detection of protein changes, the data showing the content of soluble and nonprotein nitrogenous compounds were adjusted to correspond to those of hams with the moisture content of unstored cured and smoked products (65.1%). With the exception of the increased amounts of nitrogenous materials which occurred in the ham stored 12 months at 90° F. (32.2° C.), no significance was attached to differences at the other storage temperatures. The only appreciable increase in free fatty acids occurred in 12 months at 70° and 90° F. (21.1° and 32.2° C.). The peroxide content was relatively low in all samples. Since rancidity was detected organoleptically in some aged samples, the general belief, that the peroxide value is a poor index of rancidity, was reaffirmed. The range of average pH values, 6.13 to 6.78, was narrow, and in general pH varied but little during processing and storage. The relatively higher pH values of 6.46 and 6.78 of hams stored at 70° and 90° F. (21.1° and 32.2° C.) for a period of 12 months probably can be attributed to the effects of proteolysis. The results indicate that storage produced dehydration which was inversely related to time and temperature. Significant proteolysis occurred only at 90° F. (32.2° C.), whereas marked fat hydrolysis occurred at both 70° and 90° F. (21.1° and 32.2° C.) during 12 months' storage.

NITROGEN EFFICIENCY VALUE

Samples were prepared by a previously described method *(5)*. Diets were made up and fed to rats essentially as previously described by Hoagland and coworkers *(7)*. Since the sodium chloride content of different lots of hams varied, each diet was adjusted to 3.15% salt. The average gain in weight in 30 days of 8 albino male rats per gram of nitrogen consumed was considered the nitrogen efficiency value (Table 3).

TABLE 2

Chemical analyses of cured and stored farm-style hams

Description of hams	Storage conditions	No. of hams	Moisture	Protein (N x 6.25)	Fat	Ash	Sodium chloride	Soluble nitrogen	Nonprotein nitrogen	Free fatty acid (as oleic acid)	Peroxide value m.e.q. per 1000 g.	pH
Fresh	.....	5	% 74.5	% 21.6	% 3.01	% 1.13	% 0.06	% 30.3	% 13.1	% (0.37-0.73)[2] 0.56	% 1.11	6.01
Cured and smoked	.....	4	65.1	24.1	6.42	3.08	4.30	20.2	16.3	(0.83-2.82) 1.41	0.74	6.45
Stored	6 wks., 40° F.	4	62.6	25.9	5.88	5.58	4.48	18.9 (18.2)[1]	17.3 (16.6)	(0.66-1.98) 1.35	1.52	6.13
	6 wks., 70° F.	3	61.3	26.1	6.85	5.89	5.26	18.7 (17.6)	16.5 (15.5)	(0.97-1.66) 1.20	1.32	6.20
	6 wks., 90° F.	3	61.6	27.1	6.15	6.23	5.46	20.3 (19.2)	17.3 (16.4)	(1.21-1.69) 1.37	0.87	6.30
	6 mos., 40° F.	1	61.5	27.2	3.43	6.54	6.65	19.1 (18.0)	15.3 (14.5)	1.27	5.71	6.38
	6 mos., 70° F.	2	57.3	30.4	5.80	7.57	6.69	20.5 (17.0)	17.4 (15.3)	(1.02-3.42) 2.22	1.95	6.18
	6 mos., 90° F.	1	47.8	34.3	8.93	9.30	8.74	24.1 (17.7)	23.4 (17.2)	0.72	6.55	6.18
	12 mos., 40° F.	1	54.6	31.4	4.89	9.66	8.70	19.6 (16.4)	16.4 (13.8)	2.70	6.37	6.25
	12 mos., 70° F.	1	53.5	31.8	5.87	9.46	8.75	25.4 (20.8)	20.6 (16.9)	3.92	2.38	6.46
	12 mos., 90° F.	1	43.7	37.1	9.13	9.27	9.15	37.5 (25.2)	35.2 (23.6)	11.60	4.62	6.78

[1] Figure in parentheses "( )" adjusted to show content in hams whose moisture content corresponds to that of the original cured and smoked hams (65.1%).

[2] Figures in parentheses "( )" show range of free fatty acid content.

TABLE 3

Nitrogen efficiency values of cured and stored farm-style hams [1]

Description of hams	Storage conditions	No. of hams [2]	Gain and intake in 30 days				
			Gain in weight	Feed consumed	Nitrogen consumed	Feed per gram gain in weight	Gain per gram of nitrogen
			g.	g.	g.	g.	g.
Fresh	.....	4	90	280	4.480	3.11	20.09
Stored	6 wks., 40° F.	10	112	323	5.168	2.88	21.67
	6 wks., 70° F.	10	110	320	5.120	2.91	21.48
	6 wks., 90° F.	10	99	300	4.800	3.03	20.62
	6 mos., 40° F.	3	116	333	5.328	2.87	21.77
	6 mos., 70° F.	6	122	341	5.456	2.80	22.36
	6 mos., 90° F.	4	104	318	5.088	3.06	20.44
	12 mos., 40° F.	4	127	355	5.680	2.80	22.36
	12 mos., 70° F.	5	131	358	5.728	2.73	22.87
	12 mos., 90° F.	6	107	326	5.216	3.05	20.51

[1] Average gain in weight of 8 male rats in 30 days.
[2] A minimum of 3 hams were required per determination.

When the results on the fresh hams—20.1 g. gain per g. of nitrogen consumed—were used as a basis for comparison, storage of hams produced no detrimental effects upon the nitrogen efficiency value.

VITAMIN CONTENT

For vitamin analyses, a sample representative of the entire lean portion of each ham was prepared by grinding the tissue three times through a fine food chopper with careful mixing after each grinding. Thiamine and riboflavin determinations were carried out simultaneously on the same extract, by fluorometric methods; and niacin was determined microbiologically. The methods for the 3 vitamins were essentially similar to those described by the Association of Vitamin Chemists *(1)*. Results are shown in Table 4.

In interpreting the data in Table 4, it must be recognized that the vitamin content of hams varies widely, and that the vitamin content of original individual hams could not be determined under the conditions of the experiments. The vitamin values ranged greatly among the groups. In the case of thiamine, the content ranged from 11.0 to 29.9 γ per g. of protein; riboflavin 7.6 to 11.0 γ; and niacin 99.4 to 152.3 γ. Similarly, large variations have been reported in the literature with respect to the vitamin content of fresh and cured pork. Schweigert, McIntire, and Elvehjem *(11)* showed variations of thiamine, riboflavin, and niacin content from 33.9 to 51.4; 12.8 to 16.5; and 122 to 163 γ per g. of protein, respectively. McIntire and coworkers *(9)*, in a study of fresh and cooked pork, reported that the thiamine content ranged from 7.4 to 15.2; riboflavin from 1.6 to 3.0; and niacin from 31 to 49 γ per g. of fresh loin. Vail and Westerman *(13)* found a wide variation in thiamine content among cuts from the same picnic ranging from 18.5 to 32.4 γ per g. on a moisture-free basis. In the case of cuts from another picnic obtained from another carcass, the range was from 23.1 to 44.1. Dann and Handler *(3)* reported that the niacin content of fresh pork muscle varied from 41 to 102 γ per g.

Since lean fresh pork is an excellent source of thiamine, riboflavin, and niacin, any changes that took place in the vitamin content during the processing and storage periods are of particular interest. From inspection of the data in Table 4, the apparent loss of thiamine during curing was 3.2 γ (10.7%) with further losses during storage ranging from 4.4 to 15.7 γ (16.4 to 58.8%). In the case of the riboflavin and niacin, the data show that there were apparent gains which are assumed to mainly reflect variation between samples. These data indicate that no deterioration of riboflavin and niacin occurred, and are substantially in agreement with the results of Schweigert *et al. (11)* who reported recovery of thiamine, riboflavin, and niacin of 85, 104, and 106%, respectively, from cured hams.

Including samples stored for lengthy periods at high temperatures, all the hams were an excellent source of riboflavin and niacin—and thiamine as well. The content of thiamine, however, was reduced during processing and storage.

TABLE 4

Average vitamin content of cured and stored farm-style hams

Description of hams	Storage conditions	No. of hams	Thiamine		Riboflavin		Niacin	
			S [1]	P [2]	S	P	S	P
Fresh	.....	3	6.5	29.9	1.6	7.6	23.1	107.1
Cured and smoked	.....	3	6.4	26.7	2.3	9.7	24.0	99.4
Stored	6 wks., 40° F.	3	5.5	21.4	2.8	11.0	32.8	126.7
	6 wks., 70° F.	3	5.4	20.8	2.7	10.5	28.9	110.7
	6 wks., 90° F.	3	5.1	18.9	2.8	10.3	33.2	122.4
	6 mos., 40° F.	1	5.6	20.7	2.7	10.0	40.0	145.8
	6 mos., 70° F.	2	5.9	19.5	2.7	8.9	46.3	152.3
	6 mos., 90° F.	1	7.6	22.3	3.7	8.4	39.2	114.2
	12 mos., 40° F.	1	5.4	17.1	3.0	9.5	41.3	131.7
	12 mos., 70° F.	1	4.5	14.2	2.7	8.4	43.8	137.9
	12 mos., 90° F.	1	4.1	11.0	2.9	7.8	40.6	109.4

[1] Values in micrograms per gram of sample.
[2] Values in micrograms per gram protein.

ORGANOLEPTIC ANALYSES

The hams were prepared for taste testing in a manner similar to that previously employed in testing commercially-cured hams *(14)*, using a 1-to-5-point score sheet, with descriptive adjectives as indicated below:

Score	Intensity	Desirability
1	Imperceptible	Undesirable
2	Perceptible	Acceptable
3	Slightly pronounced	Slightly desirable
4	Moderately pronounced	Desirable
5	Pronounced	Very desirable

Judgments were made by a panel composed of from 8 to 10 experienced taste testers, on the desirability and intensity of the lean and fat tissues of the various hams. Color, tenderness, juiciness, and the degree of saltiness of the lean portion were also judged.

With respect to the keeping quality of these stored products, the following was observed: Of 6 hams stored at 40° F. (4.4° C.), 3 out of 4 tested after 6 weeks' storage were found to be desirable; one tested after 6 months' storage was found to be sound; and the remaining ham when tested after 12 months' storage was also palatable. Of 7 hams stored at 70° F. (21.1° C.), one out of 4 tested after 6 weeks, one of 2 tested after 6 months, and the remaining ham stored 12 months, were found to be undesirable. Of 5 hams stored at 90° F. (32.2° C.), one of 3 tested after 6 weeks, one after 6 months, and the other after 12 months, were found to be undesirable. The undesirable flavors which developed during storage were characterized as moldy, cheesy, musty, or rancid. Hams stored at 40° F. (4.4° C.) aged slightly but remained edible after 12 months' storage. Products stored at 70° F. (21.1° C.) were appreciably deteriorated if stored 6 months or longer; advanced deterioration occurred in those stored at 90° F. (32.2° C.) for 6 months. As previously noted, storage at temperatures constantly maintained at 70° and 90° F. (21.1° and 32.2° C.) was considerably more drastic than normal storage on farms; consequently, these data do not directly indicate the normal keeping quality of this type of ham.

BACTERIAL CONTENT

Bacteriological counts were made by a previously reported method *(5)* on samples of the same hams used for chemical analyses. Results were reported as numbers of organisms per gram of meat. A value of less than 1000 bacteria per gram has been arbitrarily accepted as an insignificant number of bacteria.

Twenty-six samples were examined, of which 19 had less than 1000 bacteria per gram. Five fresh and 4 freshly cured and smoked samples also had an insignificant count. Four samples stored 6 weeks at 40° F. (4.4° C.) had less than 1000 bacteria per gram. Of 3 samples stored 6 weeks at 70° F. (21.1° C.), two were found to have an insignificant count, and the remaining ham had an unexplained estimated count of 30 million organisms. Three hams stored for 6 weeks at 90° F. (32.2° C.) were found to have less than 1000 bacteria per gram.

After 6 months' storage a ham held at 40° F. (4.4° C.) had an insignificant count; two hams held at 70° F. (21.1° C.) also had an insignificant count; and a ham stored at 90° F. (32.2° C.) had a count of 290,000 organisms. Three hams stored for 12 months respectively at 40°, 70°, and 90° F. (4.4°, 21.1°, 32.2° C.), contained 135,000, less than 1,000, and 1,030 bacteria per gram. A majority of the bacteria in the hams were non-pathogenic micrococci, and none was found to be anaerobic.

These results indicate that this method of farm curing generally produces hams which are wholesome from the standpoint of both numbers and types of bacteria and not ordinarily subject to bacterial spoilage on storage. There was no apparent correlation between bacterial counts and storage conditions. Since the contrary was true in the case of palatability scores, the data suggest that bacterial contamination was not the decisive factor in determining the storage life of the hams.

SUMMARY AND CONCLUSION

A study was conducted to provide data on the composition, nutritive value, and the effects of storage on hams dry cured with salt only. The hams were cured and smoked and stored at 40°, 70°, and 90° F. (4.4°, 21.1°, and 32.2° C.), for 6 weeks, and 6-and-12 month periods. Data were obtained on weight losses, chemical constituents, nitrogen efficiency values, vitamin content, palatability, and bacteriological flora.

The results showed that an average weight loss of 11.5% occurred during processing. Appreciable weight losses occurred during storage; these depended on time, temperature, and relative humidity. It was shown through a statistical analysis that the salt content of farm-style hams varied widely, indicating a need for a technique to produce a more uniform product.

The content of protein, fat, ash, and sodium chloride increased to the degree that hams became dehydrated during storage. During storage, appreciable increases in amounts of soluble and nonprotein nitrogenous compounds occurred only in a sample stored at 90° F. (32.2° C.) for 12 months, in which some protein degradation presumably occurred. An appreciable amount of fat hydrolysis occurred in hams stored for 12 months at 70° and 90° F. (21.1° and 32.2° C.).

The processing and storage of the hams had no detrimental effects upon the nitrogen efficiency value.

No deterioration of riboflavin and niacin occurred during processing and storage, but a reduction in the thiamine content of the hams was observed.

Hams stored at 40° F. (4.4° C.) aged slightly during 12 months' storage; those stored at 70° F. (21.1° C.) deteriorated appreciably on storage of 6 months or longer, while those stored at 90° F. (32.2° C.) were scored *undesirable* after 6 months' storage.

The hams were in general wholesome from the standpoint of numbers and types of bacteria. Based on the data, it was concluded that bacterial contamination was not the decisive factor in determining the edible storage life of the hams.

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Studies on the Preservation of Bread by Freezing[a]

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The successful preservation of freshness in frozen bread was shown to depend on adequate control of rates of freezing and defrosting, suitable storage conditions, and use of strictly fresh bread. Physical measurements and organoleptic appraisals were used to evaluate the effects of variations in freezing procedures. For best results, bread should be frozen as soon as possible after baking; it should be frozen and defrosted as rapidly as possible; and it should be stored at 0° F. or below, separate from other strongly flavored or odorous materials.

Commercial possibilities for the frozen preservation of bread depend on the ability of freezing to preserve qualities of "freshness" and on the extent to which the extra costs can be held within reasonable limits by other changes in production and sales methods. Previous reports from this laboratory *(5, 6)* described the effects of temperature, air velocity, and loaf-position on rates of freezing of wrapped and unwrapped bread. The present paper reports further studies of changes in bread that result from freezing, frozen storage, and defrosting as followed by measurements of crumb firmness and by organoleptic comparisons.

Early references on storage of bread in the frozen state are reviewed by Cathcart and Luber *(4)*. In addition, these workers showed that the development of an "off" aroma is the principal factor limiting the time that bread can be kept salable by freezing. Bread stored at —7.6° F. (—22° C.) remained salable for about 40 days. Bread stored at higher temperatures developed the characteristic off aroma sooner, and that stored at lower temperatures developed it more slowly. Even at the lowest temperature studied, —31° F. (—35° C.), another kind of deterioration in quality appeared—a gradual decline in compressibility and swelling power of the crumb. Later work by Cathcart *(3)* indicated a possible relation between the off aroma and atmospheric oxygen. Bread hermetically sealed in normal atmosphere before freezing remained salable for approximately a year, while bread sealed in vacuum remained not only salable but also quite similar to fresh bread for this same period.

Weberpals *(10)* has described the successful frozen storage of bread and rolls at 4° to 6° F. and at —25° to —35° F. for 3 months, at which time the products were still fresh and salable. Other recent reports on storage of frozen bread *(1, 5, 9)* stress the importance of maintaining low and, especially, uniform storage temperatures and of freezing and defrosting bread rapidly, but objective appraisals of the effects of specific factors on quality are generally lacking. The following study was conducted to measure the effect of some of these factors on preservation of quality in frozen bread.

MATERIALS AND METHODS

The bread used in these experiments was commercial white pan bread wrapped in the customary waxed paper and obtained from two wholesale baking companies about 2 hours after baking. Most of the bread was round-top, but a few experiments were made with sandwich-type bread. Bread from the two baking companies gave essentially identical results and was used interchangeably. Large (22.5 oz.), commercially sliced loaves were used for experiments in which organoleptic ap-

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praisals were made by a taste panel. Otherwise, unsliced 22.5-oz. loaves were used so that experimental conditions would be as similar as possible to those used in previous experiments on freezing rates *(6)* in which unsliced bread was required to obtain uniform temperature readings.

Crumb firmness readings were made with a Baker Compressimeter,[b] equipped with a pressure plate 36 mm. in diameter. When necessary, bread slices were individually sealed in cellophane bags and allowed to come to room temperature before firmness was measured. Hand-sliced bread was cut ¼ inch (19 mm.) thick by means of a miter box. This slice thickness was selected to minimize possible variations due to hand slicing, particularly with very soft freshly baked bread. The firmness values obtained, therefore, might be expected to be slightly lower than for the usual ½ inch (13 mm.) thickness of commercially sliced bread, but measurements made for both slice thicknesses in bread 2 to 3 and 24 hours of age agreed quite closely. Other aspects of this comparison were discussed previously *(7)*.

Firmness values were determined as averages for 10 or more slices from the center section of each of at least 3 replicate loaves for both commercially sliced and unsliced bread. Whole slices were used for firmness readings and no attempt was made to avoid the effect of shear on firmness measurements.

Taste-panel ratings represent averages of 4 separate comparisons of the experimental treatments made at 2 sessions each during 2 successive days by at least 8 trained panel members. Judges were asked to rank the samples in order of freshness so that the freshest sample would receive the rating of 1, the next freshest 2, and so on. This method of testing gives no indication of freshness in an absolute sense; comparisons are restricted to the samples actually examined in any one experiment. In no case can freshness rankings be compared validly between experiments unless a common factor such as a fresh bread control furnishes a link between them (as in Table 6, for instance).

Freezing and defrosting times for the white bread used in these experiments are defined as the times required to reduce the center temperature of the loaf from 70° to 20° F. and to raise it from 0° to 70° F., respectively. Bread temperatures were measured with thermocouples and a recording potentiometer, as described previously *(6)*.

RESULTS AND DISCUSSION

Effect of age of bread at time of freezing. Because staling occurs at its most rapid rate during the first few hours after baking, best preservation of freshness should logically be obtained by freezing bread as soon after baking as possible. The findings shown in Table 1 demonstrate the sensitivity of a taste panel and firmness measurements to relatively small differences in the age of bread at the time it was frozen.

[b] Mention of trade names or equipment does not constitute endorsement by the U. S. Department of Agriculture.

TABLE 1

Effect of age of bread at time of freezing on firmness and taste-panel evaluation of freshness after defrosting

Age at time of freezing, hr.	Firmness, g./4 mm. compression[1]	Mean rank by taste panel[2]
Freshly defrosted		
4	92	1.3
11	109	1.8
34	131	2.9
48 hr. after defrosting		
4	172	1.2
11	183	2.3
34	201	2.5

[1] Minimum significant difference at 5% point = 15 g./4 mm. compression.

[2] Minimum significant difference at 1% point = 0.4 for the freshly defrosted bread and 1.1 for the bread tested 48 hours after defrosting. Comparisons in rank cannot be made between results obtained at the separate testing times.

For this experiment a large number of commercially sliced and wrapped loaves of round-top bread were divided into 3 lots. One lot was frozen (at —30° F.) about 4 hours after the bread was baked. The remaining lots were held at 68° F. Eleven hours after baking the second lot was placed in the freezer; 34 hours after baking the third lot was similarly frozen. Sample loaves from each lot were then defrosted for firmness measurements and taste-panel evaluations by allowing them to stand at room temperature for 4½ to 5 hours. The panel ranked the samples in order of freshness as judged by firmness, flavor, or both. Other samples of the defrosted bread were held at room temperature in sealed cans for 48 hours before being tested.

Firmness values (Table 1) were significantly different for all 3 treatments of bread immediately after defrosting and when tested 48 hours after defrosting, excepting only the difference between the 4- and 11-hour-old samples. The panel ratings paralleled the firmness values, although the difference between samples frozen at 11 and 34 hours of age and tested 48 hours after defrosting was nonsignificant. The sensitivity of the panel to the relatively small differences in age of the first 2 lots of bread at time of freezing is particularly noteworthy in that panel evaluations might parallel consumer evaluations somewhat better than would firmness measurements. The results of both methods, however, show clearly the desirability of freezing bread as soon after baking as possible.

Effect of rate of freezing and defrosting. The length of time required to reduce the temperature of bread below its freezing point and to raise it again during defrosting affects firmness of the crumb *(5)*. The following experiments show how much some specific differences in freezing and defrosting rates affect crumb firmness and panel evaluations of freshness.

The values in Table 2 show the effect of different freezing times on the firmness of 3 samples of unsliced, round-top bread frozen at different rates but defrosted alike (at room temperature for 5 hours). The bread frozen in the least time increased only a relatively small amount in firmness, and a portion of this increase undoubtedly occurred during the defrosting necessary to prepare the samples for measurement. The amount of this increase in firmness is approximately equal to that found at room temperature (74° F.) in unfrozen bread during the first 12 hours after baking *(7)*. The larger increases in firmness caused by the slower freezing rates correspond to those found for 2 to 3 days at room temperature.

TABLE 2

Effect of freezing time on crumb firmness (defrosting time was about 5 hrs.)

Freezing time, hr.	Av. increase in firmness, g./4 mm. compression[1]
0.5	16
1.5	32
3	57
7	71

[1] Minimum significant difference at 5% point = 13 g.

Table 3 shows the effect of different defrosting times on bread frozen at —20° F. in about 80 minutes. De-

TABLE 3
Effect of defrosting time on crumb firmness (freezing time was about 80 min.)

Defrosting time, hr.	Av. increase in firmness, g./4 mm. compression[1]
2.3	13
5.5	32
10.8	31

[1] Minimum significant difference at 5% point = 10 g.

frosting time had a much smaller effect on firmness of the bread, although appreciable increases were obtained when the time was as long as 5 hours or more. The small firmness increases caused by the most rapid defrosting and freezing times used in these experiments indicate that bread can be frozen and defrosted with scarcely any effect on quality.

The effect of different freezing and defrosting times on freshness of bread as evaluated by a taste panel was determined in the following experiments. Commercially sliced, round-top bread was frozen in approximately an hour and a half at —30° F. or in about 8 hours at —10° F. while packed in a cardboard delivery carton. Loaves from each lot were then defrosted either slowly by standing at room temperature for 5 hours or rapidly as individual slices sealed in Cellophane bags and allowed to stand at room temperature for 30 minutes. Results of the 4 treatments on firmness measurements and panel judgments made immediately and 48 hours after defrosting are shown in Table 4. The panel ranked the samples for freshness on the basis of firmness, flavor, or both.

Panel judgments and firmness measurements were both significantly different for the two freezing rates used regardless of method of defrosting. With rapid freezing the method of defrosting had no significant effect on firmness measurements until 48 hours after defrosting, but with slow freezing the slowly defrosted samples were rated better than the rapidly defrosted samples by both evaluations when tested 48 hours after defrosting—results contrary to expectations. Subsequent repetition of part of the experiment with both round-top and sandwich bread confirmed the finding that slices from the slowly defrosted (5 hr.) loaves were

TABLE 4
Effect of freezing and defrosting time on firmness measurements and panel evaluations of freshness of frozen-defrosted bread

Rate of freezing	Rate of defrosting	Firmness, g./4 mm. compression[1]	Mean rank by taste panel[2]
Freshly defrosted			
Fast	Fast	108	1.4
Fast	Slow	102	1.6
Slow	Fast	160	3.6
Slow	Slow	148	3.4
48 hours after defrosting			
Fast	Fast	229	1.8
Fast	Slow	180	1.8
Slow	Fast	242	3.6
Slow	Slow	225	2.8

[1] Minimum significant difference at 5% point = 18 g./4 mm. compression.
[2] Minimum significant difference at 1% point = 0.4 for the freshly defrosted bread and 0.5 for the bread tested 48 hours after defrosting. Comparisons in rank cannot be made between results obtained at separate testing times.

superior to the rapidly defrosted (30 min.) individual slices on the basis of firmness measurements made 24 or more hours after defrosting. Still further investigation indicated that this discrepancy was probably due to a difference in moisture content of the center section of the slices after the different defrosting methods. Results obtained with the sandwich bread are shown in Table 5.

The moisture content of the center section of slices defrosted slowly in the intact loaf remained constant up to 48 hours; whereas in the rapidly defrosted slices sealed and stored in cellophane bags the moisture of the center section decreased steadily until at the end of 48 hours after defrosting it was more than 3% below that of the slowly defrosted bread. Bechtel and Meisner *(2)*

TABLE 5
Firmness and moisture content changes with aging at room temperature in sandwich bread defrosted by different methods

	Hours after defrosting	Firmness, g./4 mm. compression[1]	Center-crumb moisture, %
Rapid defrost[2]	2	85	43.9
	4	90	43.5
	24	113	42.3
	48	140	41.4
Slow defrost[3]	2	79	44.5
	4	80	44.6
	24	100	45.0
	48	120	44.7

[1] Minimum significant difference at 5% point = 13 g./4 mm. compression.
[2] Individual slices in Cellophane bags at room temperature.
[3] Whole loaf at room temperature.

showed that a difference of 2% in crumb moisture was sufficient to cause significant differences in crumb compressibility and in the human judgment of freshness of bread; hence, it appears that moisture differences in these particular experiments were large enough to cause the differences in crumb firmness observed after the two defrosting procedures. [Additional information concerning the distribution of moisture in unfrozen, frozen, and frozen-defrosted bread is presented separately *(8)*.]

Effect of temperature on frozen storage. It is often assumed that firming changes cease once bread is frozen and that it can be stored indefinitely without further change, although Cathcart and Luber *(4)* found initial decreases in both crumb softness and swelling power during storage at temperatures as low as —31° F.; however, during prolonged storage at the latter temperature an unexplained rise in softness and swelling power occurred.

The experimental values in Tables 6 and 7 show the result of an attempt to measure the effect of storage temperature on flavor of frozen bread independently of firmness changes that also occurred. Commercially sliced, round-top bread in commercial waxed wrappers was frozen at —20° F. (90 to 100 min. freezing time) and stored in cardboard delivery cartons at one of several temperatures below the freezing point of bread (20° F.). After the indicated intervals, samples of each lot were defrosted in a standard time of 5 hours and compared by taste-panel evaluation and firmness measurements. Panel judges were asked to rank the sam-

TABLE 6

Effect of temperature of frozen storage on firmness of bread (g./4 mm. compression)[1]

Days in storage	Temperature of storage, ° F.			Unfrozen control[2]
	0°	10°	15°	
0	90[3]	.....	.....	.....
7	96	110	134	100
14	100	111	149	103
28	96	116	153	92
46	103	121	161	.....

[1] Minimum significant difference at 5% point = 12 g./4 mm. compression.

[2] Unfrozen bread stored approximately 30 hours at room temperature.

[3] The fresh unfrozen bread used had an average firmness of 71 g./4 mm. compression; after freezing, overnight equilibration to 0° F., and immediate defrosting, it had a value of 90 g./4 mm. compression.

TABLE 7

Effect of temperature of frozen storage on average rank in freshness of flavor in bread as judged by taste panel[1]

Days in storage	Temperature of storage, ° F.			Unfrozen control[2]
	0°	10°	15°	
7	2.0	2.1	3.5	2.5
14	2.0	2.2	3.4	2.5
28	2.0	2.5	3.7	2.0

[1] Minimum significant differences at 5% point = 0.7, 0.9, and 0.9 for the 7, 14, and 28 day comparisons, respectively. Comparisons in rank between different storage periods are valid only as they relate to the unfrozen control bread.

[2] Unfrozen bread stored approximately 30 hours at room temperature.

ples on the basis of freshness of flavor only. Unfrozen bread about 30 hours old was used as the control sample in order to minimize any effect of differences in firmness on flavor judgments.

Bread stored at 15° F. increased relatively rapidly in firmness during the first 2 weeks but subsequent increases occurred more and more slowly. At 10° F., a significant increase in firmness occurred in the first week, but later changes were much slower. At 0° F., more than 6 weeks were required for a significant increase in firmness. The bread was then equivalent in firmness to the unfrozen control bread, which was slightly more than one day old and still considered fresh from the standpoint of retail sale.

Although the freezing point of bread appears to be about 20° F. *(6)*, a frozen loaf does not become rigid to the touch until its temperature falls below 10° F. At 15° F. a frozen loaf yields readily to moderate hand pressure; at 10° F. it is only slightly compressible, and at 0° F. the resiliency is completely gone.

Results of organoleptic comparisons of frozen bread (Table 7) indicate a significant loss in freshness for bread stored at 15° F. by the end of the first week of storage. The bread stored at 10° F. declined much more slowly in freshness in comparison to the other samples, while the control bread improved its relative position during the experiment. Bread stored at 0° F. retained its original position in the ratings. Only the differences in bread stored at 15° F. were statistically significant. Organoleptic appraisal was terminated at the end of the fourth week because of the appearance in the bread of the odor and taste of the solvent of the paint on the walls of the cold rooms. (This pick-up of foreign odor and flavor was also observed in bread stored at lower temperatures for longer times, so that storage of frozen bread with materials of strong or undesirable odor should be strictly avoided, if possible.[5])

The greater firmness of samples stored at 15° F. very likely influenced the taste-panel results somewhat, but at the end of the second week of storage another defect appeared which substantiated an obvious decline in quality. A narrow opaque band, reminiscent in appearance of freezer-burn in meats, appeared as a complete ring about ¼-inch inside the crust of each slice. Similar opaque areas have been observed in other breads stored at 0° F. for much longer periods of time, but their occurrence was sporadic. No explanation of this phenomenon is available, and no reference to it in the literature was found, although it has been observed elsewhere.[6] Preliminary x-ray diffraction patterns made with crumb from affected and adjacent normal areas appeared to be identical.

Results of these storage experiments clearly indicate that bread should be stored at 0° F. or below for best retention of its original quality and, even then, storage probably should not exceed a month. For storage of a few days to a week, a temperature of 10° F. might be permissible with but a slight sacrifice of quality.

Effect of unstable storage temperature. The effects of unstable storage temperatures on frozen foods are well known, and caution against storage temperature fluctuation has been advised with respect to bread *(1, 9)*. Some effects of temperature fluctuation on frozen bread were measured in the following experiment. Unsliced, round-top bread in commercial waxed wrappers was frozen at —20° F. and divided into 2 lots. One lot was stored in cardboard delivery cartons at 0° F. The other was stored on open shelves in a cold room in which the temperature was adjusted automatically to fluctuate between 0° and 20° F. on a 24-hour cycle. Samples from each lot of bread were defrosted for 5 hours at room temperature, and firmness and moisture determinations were made. The data on moisture distribution in the breads are presented elsewhere *(8)*.

The firmness values in Table 8 show that the rate of firmness increase in bread stored at variable tempera-

TABLE 8

Effect of a variable storage temperature on firmness in frozen bread (temperature fluctuated between 0° and 20° F. on a 24-hour cycle)

Days in storage	Firmness, g./4 mm. compression
0	94
7	123
14	131
28	165

[1] Minimum significant difference at 5% point = 18 g./4 mm. compression.

ture was between those found for bread stored at stable temperatures of 10° and 15° F. (Table 6), allowing for the small difference in firmness of the frozen, unstored starting materials. (Bread stored at 0° F. did not change in firmness.) These observations show that changes during storage at a fluctuating temperature are greater than expected from storage at a constant temperature equal to the average of the varying temperatures, in this case 10° F. This is due to the fact that

[5] Personal communication from W. J. Hoover, of the Refrigeration Research Foundation, Colorado Springs, Colorado.

firming rates increase in a non-linear fashion as the temperature increases and pass through a maximum above the freezing point *(7)*. In other words, the increase in rate above 10° F., for instance, is larger than the decrease in rate below 10° F. The net gain in firmness for the bread stored equal times above and below 10° F. would, therefore, be greater than for bread stored for the whole time at 10° F.

These findings help to illustrate the generalities that unfrozen bread should be stored at as high a temperature as possible before moisture losses or mold growth become limiting and that frozen bread should be stored at as low a temperature as possible before costs become limiting.

Effect of refreezing after defrosting. Circumstances can occur during commercial handling of frozen bread in which refreezing of defrosted bread would be desirable. To measure the effect of such refreezing on firmness, a number of unsliced round-top loaves were frozen (at —20° F. in about 90 min.), allowed to equilibrate at 0° F. overnight, defrosted for 5 hours at room temperature, and then refrozen. The cycle was repeated twice. Sample loaves were withdrawn after each defrosting for measurements of crumb firmness, which are shown in Table 9.

TABLE 9
Effect of repeated freezing and defrosting on firmness of bread (g./4 mm. compression)[1]

Number of cycles	Firmness	Difference
0 (fresh)	57	—
1	85	28
2	102	17
3	114	12

[1] Minimum significant difference at 5% point = 5 g./4 mm. compression.

As expected, each time the bread was refrozen, a significant increase in firmness occurred, although with each cycle the size of the increases became smaller. In this experiment no more than 2 or 3 hours elapsed between completion of a defrosting step and the freezing part of the next cycle. Under practical conditions any additional standing unfrozen would increase firmness.

SUMMARY AND CONCLUSIONS

Both physical measurements of crumb firmness and organoleptic judgments of a taste panel demonstrated the desirability of freezing bread as soon after baking as possible. The panel was quite sensitive to a relatively small difference in age of bread at time of freezing. The sensitivity was probably based more on differences in firmness and texture of crumb than on flavor.

Physical and organoleptic results both demonstrated a greater influence of rate of freezing as compared with rate of defrosting on quality of bread, when compared immediately and also up to 48 hours after defrosting. The freezing and defrosting of bread under conditions assumed to be reasonably available for good commercial practice caused an increase in firmness approximately equal to that for unfrozen bread at room temperature during the first 24 hours after baking; however, previous work showed that the shelf life of such frozen-defrosted bread was unaffected.

The temperature of storage affected quality of frozen bread. A temperature of 0° F. or below was required to prevent a significant increase in firmness during storage for longer than one week; 10° F. was permissible only for a few days. Bread stored 4 weeks at 10°, as well as at 0° F., could not be distinguished from day-old unfrozen bread on the basis of *flavor* alone.

Freezing does not prevent absorption of foreign odors and flavors by bread, although it is delayed by decreasing the storage temperature.

Re-freezing of bread caused substantial increases in crumb firmness, but the increase became smaller each time the process was repeated.

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Flavomatics in Food[a]

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Less than 100 years ago the household was more or less a self contained unit. It produced within itself practically all the necessities for sustaining life. During that period the term, *chemical food additives,* was unknown. Benzaldehyde was not associated with a cherry flavor, nor was vanillin available for duplicating of the luxury of expensive vanilla flavoring. Our ancestors had no craving for skillfully manufactured ice cream, carbonated beverages, candies, cakes or modern seasonings. They were non-existent on the market.

Modern generations have been from birth reared and accustomed to accept taste trends, and flavorings are a daily and accepted necessity in every day life. The old fashioned home preparations have been replaced with scientifically manufactured foods. The desire for a variety of palatable and appetizing taste sensations that makes the consumption of food a pleasure, not a necessary daily task, is a basic consumer characteristic of our times.

Regardless of headline news features, relating to chemical food additives, it is a difficult feat to break the hold of an accepted fact—that flavorings add zest to foods. The vivid imagination of an H. G. Wells and a Jules Verne are being brought to reality by the magic of chemistry. The chemists' test tubes have made the luxuries of yesterday pass quickly into the necessities of today. These wonders have been brought about by the laboratory duplication of natural processes via synthesis and by the production of synthetic organic chemicals, many of which have been used in the scientific manufacture of foods. These wonders have not been easily achieved, and they are worthy of our admiration and respect.

Up to about 1950, chemicals were considered a boon to mankind. When the report of the Delaney Committee brought forth the facts that several hundreds were used in the preparation of foods as additives, with the possibility that some may be harmful and injurious to health, *chemical food additives* became a "hot subject." One wonders *why*. Perhaps it is due to the fact that many chemicals have names not easily recognized by the average consumer. He probably never associates table salt with the chemical "sodium chloride," nor is he aware that the quantity of any "chemical" consumed would help define the words "harmful chemical." Added to this possible cause of suspicion is the fact that well-meaning "food additive investigators" have found that excessive quantities of some chemicals are difficult to feed as a diet to a test animal and can create physical harm when force fed.

These findings distorted by feature-hungry writers have helped create public distrust in the benefits of certain chemicals in foods, and have necessitated formulation and introduction of legislative activity to help define the word "harmful" and "deleterious" for the protection of the consumer and the manufacturer.

Perhaps it may be wiser in the future to refer to the subject of chemical additives in foods, as just food additives, since in most instances foods are just chemicals in combinations. By omitting the word *chemical,* it may allay the implied "poison" stigma and alleviate the average consumer's fear of the unknown—which is blended with distorted facts relating to the use of chemicals in foods. Thus, chlorine, a well known and feared poisonous gas, does not frighten the public. They have been educated to realize that very small amounts in water can be useful, that there need be no fear of harm.

Imitation food flavors are composed of synthetic organic aromatic chemicals sometimes used alone or in combination with natural products. Many of these imitation flavors are chemically identical with those found in nature. Analysis of fruit juices has proved the presence in these healthful products of chemicals such as hydrocarbons, alcohols, ethers, esters, ketones, aldehydes, organic acids, and other carbonyl compounds. They are identical with the synthetic aromatic chemicals used by skilled flavor chemists or flavorists to reproduce the imitation flavorings of commerce. These chemicals are necessary in food flavorings not only for controlled accentuation and high concentration but also for economy.

Some background factors. To trace the dawn of synthetic organic aromatic chemicals for flavorings, one must begin with the history of the essential oils. Undoubtedly after man's curiosity was aroused as to isolating and concentrating the delectable flavor of a fruit or root, he managed to obtain a steam distillate or extraction. The studies of essential oils began before the Birth of Christ. It was not until the 17th and 18th centuries that scientific investigations improved the knowledge of essential oil isolations by distillation. Studies of the composition of these oils and identification of their natural isolates led to the synthesis of aromatic chemicals, and a new field of organic chemistry.

Some of the historical highlights of the birth of imitation flavorings are as follows:

1782—Scheele prepared ethyl acetate.

1851—London World Fair—solutions of esters were introduced as artificial flavors.

1867—Perkin prepared coumarin.

1874—Tieman prepared vanillin.

[a] Presented before the Fifteenth Annual Meeting of the Institute of Food Technologists, Columbus, Ohio, June 14, 1955.

1904—Darzens prepared ethyl methyl phenyl glycidate (aldehyde C-16).

1908—Shukov and Shestakov prepared aldehyde C-14.

Many other introductions of aromatic chemicals for use in flavorings followed, and a new industry was born in the early 1900's. The foregoing list shows that the commercial use of imitation flavors is of comparatively recent origin.

There are many hundreds of aromatic organic synthetic chemicals manufactured for use in perfumes, pesticides, medicines, flavors, etc. This has led to many claims, and much confusion as to safety of these chemicals. For example, the following are rarely used in flavors: diphenyl oxide, amyl cinamic aldehyde, benzophenone, benzylidene acetone, bromstyrol, dimethyl phthalate, diphenyl methane, hydroxy citronellal, indol, scatol, musky xylene, etc. Yet the impression may exist that they are.

A new term suggested. It is recommended that the term, *flavomatics,* be associated with the synthetic aromatic organic chemicals used in proper quantities by the flavorist in the creative formulation of imitation food flavorings. Use of the word, *flavomatics,* avoids reference to *chemicals,* and creates a special classification, avoiding confusion with other chemicals never intended for, or used, in flavor preparation for the purpose of a desired taste sensation.

Although there are well over 200 *flavomatics* available for use in imitation flavor compositions, the Food Additive Committee of the Flavoring Extract Manufacturers Association of the U. S. has listed (Table 1) the primary *flavomatics.* They are arranged in groups in order of their importance, type of usual flavor use, and their general average calculated use in parts per million, as found in finished foods. No identification as to volatility or heat loss has been given.

These flavomatics, when skillfully blended in suitable dilution medias, are present in finished foods in only fractions of a percent, and this should be taken into consideration as a controlling factor in determination of safety.

Other safeguards against excessive amounts. Another added safety feature to prevent possible abuse of flavomatics in food products is that of *palatability.* Whenever flavomatics are used in excess of the above stated amounts, the taste in most instances is objectionable. Should anyone quite by accident, taste the actual flavomatic itself, it would cause him to reject it from the mouth, due to the sharp, unpleasant taste.

Flavomatics when incorporated into foods are also subject to many physical as well as possible chemical reactions that reduce the actual amounts present in the finished foods or may alter their composition. Flavored foods like cakes, cookies, pies, custards, puddings, meat, fish, candy, are baked, boiled, braised, broiled, caramelized, fried, parboiled, roasted, stewed, steamed, or simmered, etc., at temperatures ranging between 250° F. to 550° F. (121° C. to 288° C.). Flavomatics volatilize—ethyl formate at 54° C., ethyl acetate at 76° C., ethyl butyrate at 120° C., to ethyl laurate at 269° C., and so-called aldehyde C-14 at 297° C.

TABLE 1

The primary flavomatics

Aromatic chemical	Flavor	Ave. use (P.P.M.)	B.P.° C.	M.P.° C.
Group I				
Vanillin	Vanilla	31.5		81.5°
Ethyl vanillin	Vanilla	16.6		76.5°
Citral	Lemon	17.6	229°	
Benzaldehyde	Cherry, Almond	84.8	180°	
Cinamic aldehyde	Cinnamon, Cola	110.7	252°	
Methyl salicylate	Root beer Wintergreen	129.7	221°	
Amyl acetate	Banana, fruit flavors	78.4	142°	
Amyl butyrate	Banana, fruit flavors	23.7	185°	
Ethyl acetate	Fruit, rum	92.7	76°	
Ethyl butyrate	Strawberry, fruit	31.1	120°	
Methyl anthranilate	Grape	97.1	255°	
Ethyl oxy hydrate	Rum	472.7		
Anethole	Root beer, anise	133.5	235.3°	
Safrol	Root beer, anise	16.9	236°	
Menthol	Mint	111.2	215°	
Group II				
Heliotropine	Vanilla, cherry	3.4	263°	
Aldehyde C-18	Coconut	17.6	263°	
Diacetyl	Butter	17.3	88°	
Aldehyde C-16	Strawberry	10.0	271°	
Ethyl Oenanthate	Grape	8.1	187°	
Allyl caproate	Pineapple	11.7	187°	
Aldehyde C-14	Peach	8.0	297°	
Eugenol	Spice	48.8	253°	
Amyl valerinate	Peach, fruit	9.6	200°	
Ethyl valerinate	Fruit	14.4	145°	
Carvone	Spice, mint	190.3	230°	
Anis aldehyde	Cherry,vanilla	3.6	247°	
Group III				
Benzyl-acetate	Strawberry, fruit	8.8	215°	
Ethyl formate	Rum, strawberry	77.0	54°	
Ionone	Raspberry	0.9	147.5°	
Ethyl lactate	Grape	42.1	154°	
Tolyl aldehyde	Cherry	9.3	204°	
Amyl caproate	Pineapple, apple	4.4	222.2°	
Linalool	Spice	30.2	199°	
Citronellal	Rose (general)	14.20	206°	
Butyl acetate	Fruit	26.4	126.5°	
Ethyl pelargonate	Grape, fruit	2.3	228°	
Butyl butyrate	Fruit	17.9	166.4°	
Aldehyde C-10	Citrus	1.2	208°	
Ethyl heptoate	Grape, pineapple	4.6	172.1°	
Geranyl acetate	Fruit	8.4	245°	
Methyl Phenyl acetate	Honey	2.4	222°	
Group IV				
Aldehyde C-8	Citrus	0.71	165°	
Aldehyde C-9	Citrus	2.81	191°	
Cyclohexyl butyrate	Pineapple, fruit	8.3	212°	
Ethyl laurate	Spice, fruit	6.9	269°	
Linalyl acetate	Citrus	5.4	220°	

How much of the light, commonly used, esters are volatilized along with higher boiling flavomatics, is unknown, but undoubtedly, as in candy making, a portion of the flavor components is lost. Chemical reactions, by applied heat to the contained esters, aldehydes, ketones, etc., in the presence of acids, may also account for loss or altered compositions.

The actual intake of flavomatics is comparatively small—in most instances, as noted in our survey, amounting to only a fraction of a percent. As to the possible accumulative toxic effects of flavomatics, very little, if any, data have been forthcoming throughout the past years.

The average amounts of flavored foods consumed in one feeding are as follows (Table 2).

Our illustrative Use Survey, as stated for primary flavomatics, indicates the limited amounts that can, under normal circumstances, be consumed.

The annual production of flavomatics is of limited proportions when compared to other chemicals used by industry. Only vanillin enjoys a high production rate —about 1,000,000 lbs. annually. Most of the others are produced in quantities of only a few thousand pounds per year. A small amount of any flavomatic goes a long way in the final flavoring.

TABLE 2

Average amounts of flavored foods consumed at one time

Hard candy	2 ozs. (by weight)
Chewing gum	½ oz.
Non-alcoholic beverages	8 ozs.
Ice cream	4 ozs.
Baked goods	4 ozs.
Puddings	8 ozs.
Gelatin desserts	8 ozs.
Soft candies	4 ozs.

Flavors and recent legislation. Although imitation flavors may be classed as non-nutrient substances, their importance cannot be minimized with respect to need or demand. The steady trend towards new legislation governing the use of chemical food additives has brought forth world-wide interest in this subject. In daily usage are such words as toxicity, factor of safety, hazard, quantitative tolerance limitation. There are weird inferences that they cause various diseases.

Reflections have been cast on Section 406(a) of the Pure Food Laws, which limits the additions to food of substances "poisonous and deleterious." In the rush to bring forth new laws, certain manufacturers may be put in a position where they cannot comply with the letter of the law, nor give the consumer what he is accustomed to and demands. Some experts maintain that they would like a safety factor of 100%, disregarding the end use factor of the additive in question. Some suggest that non-nutrient additives to food of synthetic nature be banned; others suggest quantitative tolerance limitations be set for additives, like flavomatics—the same as are used for pesticides.

The latter may sound logical, but it would present problems that may be seen in the following break-down:

Exemption would be granted on amount used without hazard. This would require toxicity data such as: acute oral toxicity, subacute oral toxicity, chronic oral toxicity. A biochemical, metabolic (2 year study) would be entailed—at an approximate cost of $50,000.00 for each flavomatic. Complete toxicological data would be required to determine hazard, a test usually conducted at 100 times the common usage. Admitting that this may be the proper method, yet proper authoritative interpretation of the facts is most important. Moreover, toxicity data is difficult to translate into terms of human safe use levels because of:

The variation among species. Rats tolerate, for example, ten times more fluorine than man. Dogs tolerate, for example, four times more arsenic than man. Susceptibility varies within different strains, age, sex, health, etc. Sick test animals may be ten times more susceptible than healthy. Total diet is also a factor. Adding other test substances in large quantities increases the metabolic strain by the assimilation mechanism of the body.

Difficulty of detection. Finding analytical methods for detection of the flavomatic used would also be difficult. For compounded imitation flavors, this would be most difficult, if not impossible, in view of the combinations of chemicals contained in a flavor, the very small amounts actually contained in the food, and the possible physical and chemical reactions the food may be subjected to in processing.

Anyone familiar with flavor technology can forsee that the procedure based on the concept of Quantitative Tolerance Limitations is not adaptable for flavomatics, due to cost, limited production, and complicated use.

FACTS TO BE WEIGHED

Although many may believe that imitation flavors are a small issue, that they can be incorporated into a law to embrace other food chemicals, this is not so. The following facts should be weighed for special consideration in pending or future legislation.

Flavomatics have a past record of good use.

Flavomatics are used in trivial amounts in foods.

Flavomatics are necessary in foods.

Flavomatics have a "built-in safety factor" as to palatability when used.

Flavomatics are produced in limited quantities.

Flavomatics present the additional difficulty of developing methods of analyses for detection, and in many instances are chemically similar to normal constituents of food, as distinguished from preservatives, packaging materials and pesticides, which are usually quite different from food components.

Flavomatics appear in natural products and have been used in foods over a long period of time.

No manufacturer of imitation flavorings wants to use any flavomatic in his compositions that may be classified as "deleterious and injurious to human health," *if so proven*, based on practical *proven* facts.

Stabilized Lemonade Powder[a]

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A method has been developed for making a lemonade powder containing lemon solids, lemon oil, and sucrose in the proportions ordinarily present in lemonade made from fresh lemons. A 65.7° Brix concentrate can be dehydrated in a short period with a pressure of 2 mm. and final product temperature of 160° F. without undesirable effect on color or flavor of the reconstituted lemonade. The moisture level in the packaged powder can be reduced by in-package desiccation from 1.7% to below 1% in less than 2 weeks at 80° F. without affecting quality of the product.

The development of stabilized lemonade powder is one of a series of studies devoted to extension of puff-drying technology to various juices and puree concentrates. Application of the process to the manufacture of orange-juice powder *(16)* and tomato-juice powder *(5)* has been reported recently. Although the method seems applicable to all juice and puree products, differences in heat stability, in puffing characteristics, in rates of dehydration and in-package desiccation, and in storage stability require that the specific behavior of each type of powder be investigated prior to commercial trial.

Considerable work has been done on powdered lemon products. During World War II, a spray-dried lemonade type of powder, containing about 18% lemon juice solids and 82% corn sirup solids, was developed for military use and made available later for civilian use. More recently several types of powder mixes have been placed on the market. These mixes usually contain corn sirup, citric acid, dextrose, and artificial color in addition to the ingredients found in fresh lemonade (sucrose, lemon juice, and lemon oil).

This paper reports a method by which a powder containing only the components of fresh lemonade can be prepared. Concentrated lemon juice, sucrose, cold-pressed lemon oil, and, if desired, lemon juice sacs are the starting materials. The product, which is instantly soluble in cold water, tastes and looks exactly like lemonade prepared from freshly extracted juice. The advantages of such a powder with respect to lower weight, no need for refrigeration, ease of handling and attendant savings in shipping and storage are readily apparent.

ANALYTICAL METHODS

Moisture of powder was determined by a modified Karl Fischer method *(10)*. Suspended pulp in feeds and powders was determined (at 11.7% soluble solids, refractometer) by centrifuging 10 minutes, 1270 r.p.m., at a diameter of 16 inches *(17)*. Ascorbic acid analyses of feed and powder were carried out by the Loeffler and Ponting method *(7)* and reductones were assayed by the method of Wokes *et al. (20)*. Sulfur dioxide was determined by a modification of the Monier-Williams method *(11)*. Soluble solids were measured by the method of Stevens and Baier *(15)* after determination of values beyond the limits of their table and cloud stability values by the method of Loeffler *(8)*. Color development was measured on filtered, reconstituted powder (25% soluble solids) with a 4-cm. cell and a 400-465 mμ filter. Pectinesterase was determined in feed and powder by the method of MacDonnell, Jansen, and Lineweaver *(9)*. Moisture equilibria of powder were determined with the apparatus of Legault, Makower, and Talburt *(6)* and by the method of Wink *(19)* with sulfuric acid solutions used for relative humidities below 11% *(13)*. Recoverable oil in feed and powder was determined by the method described by Curl *(2)*.

PREPARATION OF POWDER

The raw materials were commercially available products. Lemon solids were obtained in the form of frozen single-strength and frozen concentrated lemon juice. Lemon juices contained 8 to 10% soluble solids and met standards in other respects *(17)*.[b] High-pulp juice *(1)* of similar quality was used as a source of juice sac material. Lemon-juice concentrate had been prepared at temperatures below 80° F. and contained 47.6% soluble solids and 0.066% oil. The citric acid concentration was 34.1%. Sucrose was commercial grade.

Preparation for drying. The particular ratio of lemon solids to sugar chosen for these studies was based upon a survey of proportions used in frozen lemonade concentrates. The lemonade powder was designed to yield, upon reconstitution, a beverage of the composition: citric acid 0.78%, soluble solids (refractometrically determined) 11.7%, added cold-pressed lemon oil 0.0035%, and 1.3% pulp as determined by the centrifuge test. On a moisture-free basis the composition was 90.1% sucrose, 6.8% citric acid, and 3.1% other lemon solids.

As a result of exploratory experiments in which the ratio of sugar, acid, and lemon solids was held constant and the concentration varied by addition of water, the feed was standardized at 65.7° Brix and consisted of 59% sucrose, 8.3% lemon juice concentrate, 28.1% lemon juice, and 4.6% added water. Water was used because the juice and concentrate had different citric acid concentrations. In the production of powder, citric acid values of these two components can be adjusted so that water additions are unnecessary. The viscosity of the feed at 20° C. (68° F.) as determined by the Stormer viscosimeter was 150 centipoises and exhibited truly viscous behavior.

The concentration range below 60% soluble solids, besides causing excessive spattering during the early drying stages, also necessitates lengthening the drying cycle to obtain a suitable product. Feed concentrations much above 66% soluble solids are not quickly attainable (because of the slow solubility of sucrose) at the temperatures necessary for the production of an undamaged feed. Differences in drying rates, puff, spattering loss and final moisture were slight between 60 and 66% soluble solids.

The absence or presence of juice sacs in quantities likely to be encountered had little effect on the processing and product.

The feed was prepared by vigorous mechanical stirring (without incorporation of air) of juice, concentrate and water and then adding sucrose slowly. When the sucrose addition had

[a] Presented at the Fifteenth Annual Meeting of the Institute of Food Technologists, Columbus, Ohio, June 12-16, 1955.

[b] Standards for single strength lemon juice: 5 to 7% citric acid by weight, oil less than 0.015%, ascorbic acid at least 30 mg./100 g., pulp less than 10%, Brix at least 8°.

been completed, mixing was continued for 20 minutes to insure homogeneity.

Dehydration. The puff drying process *(16)* consists of dehydration of a material in the liquid state in such a manner that a porous structure is formed early in the cycle and maintained throughout (Figure 1). The effectiveness of water removal from a thin-walled, puffed, liquid structure is self-evident. Control of viscosity during dehydration is the key to the process. The viscosity of the feed must be low enough to permit bubble formation

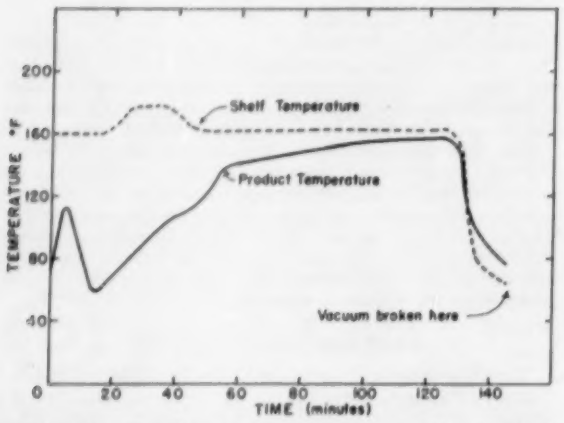

Figure 1. Time-temperature cycle for converting lemonade concentrate to lemonade powder. (Tray loading 0.5 lb. per square foot, absolute pressure 2 mm. Hg.)

at the time full vacuum is reached, but high enough so that formed bubbles will not collapse after breaking. Initial puffing is controllable chiefly by the water content and temperature of the feed material. During dehydration, a fine balance between the temperature of the partially dried material and its moisture content must be maintained so that the resultant viscosity will be high enough to prevent collapse of the puffed structure. After completion of dehydration, the product is a highly viscous sirup at the finishing temperature and must be cooled below its solidification temperature or sticky point before vacuum is released in order to prevent collapse. The product can be considered as a low-temperature glass that is a liquid at finishing temperatures but solid at room temperature. As the moisture in the product is inversely related to the temperature of solidification, the final moisture level must be low enough to produce a solid at room temperature to avoid costly handling procedures at reduced temperatures.

An excellent lemonade powder can be made by the following dehydration procedure. Feed is weighed (½ pound per square foot) and evenly distributed by gravity flow on stainless-steel trays. The trays are placed in a vacuum shelf drier (160° F. shelf temperature), pressure is reduced to 2 mm. Hg, and the shelf temperature is raised to 180°. Figure 1 shows the shelf and product temperature changes needed during dehydration and cooling. In full drier operation, the puff has been established by the time 2 mm. Hg pressure is attained. During drying, the lemonade concentrate expands from a film depth of 1/16 to 1½ inch. The moisture content of the powder at the end of the cycle is 1.7%. The product is cooled in the drier before the vacuum is released.

In determining the drying cycle given in Figure 1, shelf and product temperatures from 100° to 200° F. were explored. Poor puff and unpuffed areas were produced when shelf temperatures of 200°, 180°, and 170° F. were used and the product allowed to attain the shelf temperature. Varying amounts of flavor damage were noted in those cases where shelf temperature was held constant at 170° F. or higher. Unpuffed areas occurred at 180° F. even when the product temperature did not exceed 140° F. On some trays, unpuffed areas were within 6 inches of wet areas, appeared glassy, and may have been melted by localized heating. At shelf temperatures above 160° F. the heat transfer to the product during loading operations (5 minutes) was sufficient to reduce the viscosity beyond the point where evaporative cooling could return the viscosity to the range in which a satisfactory initial puff could be obtained. Much spattering of concentrate occurred at these low viscosity values. At temperatures below 160° F. satisfactory products are obtainable at the cost of increased drying time. Raising the shelf temperature from 160° F. to 180° F. early in the cycle (Figure 1) was designed to yield maximum evaporation rate compatible with viscosity requirements and avoidance of flavor damage.

Higher pressures gave poor puff, irregular drying, and wet spots when used with the shelf temperature sequence of Figure 1. Higher pressures might be used, provided longer cycles are not economically prohibitive.

Corn sirup solids were used in some exploratory experiments and showed no advantage over sucrose in processing and did not contribute the necessary sweetness. In addition, the powder from corn sirup solids produced a lemonade with an objectionable consistency.

The presence of a small amount of SO_2 contributed to the keeping quality of orange juice powder at elevated temperatures *(12)* and allowed the use of higher processing temperatures for tomato juice powder *(5)*. Addition of $NaHSO_3$ to lemonade powder up to 0.2%, based on soluble solids in feed, had little influence on drying characteristics. This amount of $NaHSO_3$, designed to give 125 p.p.m. SO_2 in the feed, resulted in 69% retention of SO_2 in the feed and 21% retention in the powder. The SO_2 loss is attributable to the low pH (less than 2) of the feed *(4)*. Tests to determine whether SO_2 is needed in lemonade powder are under way.

Most of the lemon oil is retained in the powder. As is true with orange-juice powder, the retained oil (0.003% on a single-strength basis) seems to contribute little to the taste of the reconstituted lemonade. Taste tests, in which the feed was compared with the resulting powder in the form of lemonade, point up the lack of flavoring potency of the retained oil. Therefore it is necessary to add the required cold-pressed lemon oil locked in a solid carrier to the powder at the time of packaging. The amount (0.029%, dry basis) added is equivalent to 0.0035% in the reconstituted lemonade.

The dehydration methods and techniques described were developed for use in batch-style operations. No serious difficulties are envisioned in adaptation of these methods for use in continuous type vacuum dehydrators, provided the user keeps in mind the time-temperature-pressure relationships needed to prevent off-flavor and off-color formation during dehydration.

Packaging. Puff-dried lemonade after screening (6-mesh) has a bulk density of 0.3 to 0.4 g. per ml. and consists of free-flowing particles, provided the relative humidity in the packaging area is kept sufficiently low. During all operations following drying, the relative humidity should be held at about 8%. At higher relative humidities, the powder will absorb moisture, become sticky, and seriously impair filling and packaging operations. The value 8% was obtained from a series of moisture equilibrium determinations (Figure 2) on the powder.

Citrus oils can be locked into various solid carriers. Strashun and Talburt *(16)* used sorbitol for this purpose as described in the patent of Griffin *(3)*. Schultz, Dimick, and Makower *(14)* discuss the use of sucrose or dextrose with or without added corn sirup and obtained excellent results with mixtures of sucrose or dextrose with corn sirup.

At the time of packaging, the proper quantities of oil (locked in a carrier) and of powder are added to the container together with the in-package desiccant (IPD). The container is evacuated (29 inches Hg) and sealed. Vacuum packing hastens the attainment of the low moisture levels (less than 1%) necessary for storage at elevated temperatures by increasing the rate of moisture transfer from the powder to the desiccant *(12)*. The IPD used in these studies was constructed in the form of a sealed envelope made from heat-sealable, sift-proof, moisture-permeable paper *(18)* with sufficient desiccant (CaO) to absorb at least 25% more moisture than was present in the powder.

Conditioning. Conditioning, defined as the reduction of moisture during storage of the packaged product at controlled temperature, was found to be necessary in order to obtain the desired

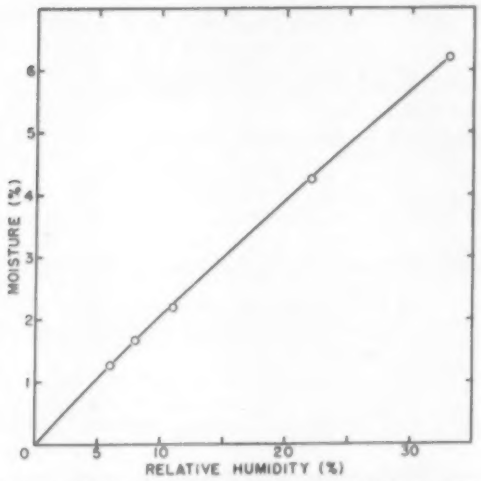

Figure 2. Moisture-relative humidity equilibria of lemonade powder at 70° F. (21.1° C.).

stability of lemonade powder at elevated temperatures (military needs). The period of time (Table 1) needed for reduction of moisture from 1.7% to below 1% was less than 2 weeks and should not present a great problem to the packer. Powder containing 2.7% moisture (prepared at a shelf temperature of 100° F. for 16 hours at 0.5 mm. Hg) required about 20 days for conditioning to this level. Organoleptic evaluation of these powders showed that no discernible changes in flavor had occurred when temperatures up to and including 80° F. were used for conditioning. Likewise, analyses revealed no changes in water-soluble color values or in ascorbic acid content.

TABLE 1

Rate of desiccation in 6-oz. cans using 10 gm. CaO (Promset construction) Vac 29"

Temp.	Moisture orig.	7 days	14 days	20 days	30 days	60 days	90 days
	%	%	%	%	%	%	%
70°F.	1.7	1.3	1.1		0.9	0.6	0.5
80°F.	1.7	0.9	0.8		0.6	0.4	0.3
80°F.	2.7	1.5	1.2	0.9			
90°F.	1.7	0.9	0.6		0.5	0.2	0.2
100°F.	1.7	0.6	0.4		0.3	0.1	0.1

QUALITY OF PRODUCT

Taste-wise and appearance-wise lemonade made with packaged powder is indistinguishable from that made with the precursor concentrate. The powder is almost instantaneously soluble in cold water. No measurable loss of ascorbic acid occurred during preparation of the powder. When lemon juice containing broken juice sacs is used, the reconstituted powder has the appearance of home-made lemonade, because some broken sacs are dispersed in the liquid, some float on the surface, and some cling to the walls of the vessel.

Comprehensive stability tests under way at present have shown that lemonade powder undergoes no discernible changes in color or flavor after 3 months' storage at 70° F. Complete results of analytical and organoleptic tests on samples stored at 70° and 100° F. for periods up to one year will be published upon conclusion of the study.

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Storage Behavior of Powdered Apple and Grape Juice Products[a]

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Data are presented on the flavor stability and extent of caking of powdered apple and grape juice products during storage for periods of up to one year at 73° F. and up to 6 months at 100° F., in 4-ounce cans. If moisture content when canned is low enough or is lowered sufficiently through inpackage desiccation after canning, both flavor retention and freedom from caking are quite satisfactory.

In previous papers *(3, 6)* the authors have described the preparation, using vacuum shelf drying, followed by grinding, of powdered apple and grape juice products. These powders, when reconstituted with water, yield beverages having pleasing natural color, flavor, and aroma similar to that of the original juices. Although the earlier papers described fully the technique of drying, grinding, and packaging these powders, they included only limited data on storage behavior. The present paper gives the results of a series of storage tests made on these powders.

PREPARATION OF POWDERS

Preparation of the powders followed the techniques given in the earlier papers *(3, 6)*. Blended concentrates of 75-80° Brix were charged to the vacuum shelf drier. These blends were prepared by thoroughly mixing together four ingredients, all liquids, in the following proportions:

Grape: 100 grams grape juice solids (as 75-80° Brix concentrate)
50 grams sucrose (as 80° Brix sirup)
1.4 grams tartaric acid[c] (as a solution containing 0.5 grams per ml.)
Sufficient 150-fold grape essence[d] (6.0 ml.) to give a ratio of essence to total solids corresponding to that of the original single strength grape juice from which the concentrate was prepared.

Apple: 100 grams apple juice solids (as 75-80° Brix concentrate)
100 grams sucrose (as 80° Brix sirup)
3.2 grams citric acid monohydrate (as a solution containing 0.85 grams per ml.)
Sufficient 150-fold apple essence (10.2 ml.) to give a ratio of essence to total solids corresponding to that of the fresh apple juice from which the concentrate was prepared.

The product, after vacuum shelf drying to about 2.5% moisture, was broken up into small pieces, blended, and ground in a small slow-speed hammer mill to produce a 10-mesh powder.

TEST PROCEDURE

The powder prepared as described, was packed into 4-ounce tin cans (size 202 x 214), and sealed either at atmospheric pressure, or under 27-inch vacuum, or in nitrogen after first evacuating to 27 inches and then breaking the vacuum with dry nitrogen. Each can contained about 95 g. of powder plus an envelope of tough paper[e,g] enclosing 9 g. of pelleted calcium oxide[f,g] as a desiccant.

Cans under test were stored in constant temperature rooms at 35° F., 73° F., and 100° F. Controls were kept at 0° F. At regular intervals during the test the products were evaluated for caking, sampled for moisture, reconstituted, and tasted. If tasting of a particular sample could not be done immediately, the powder was transferred to a sealed jar and held at 0° F. until tasted.

[a] Designation of the products described here has not as yet been made by the Food and Drug Administration. The terms used here are for purposes of description without implication of what labeling might be required in commercial use.

[b] A laboratory of the Eastern Utilization Research Branch, Agricultural Research Service, United States Department of Agriculture.

[c] Tartaric acid was not used in making up the concentrate dried to powder for storage Test No. 1.

[d] Essence is an aqueous concentrate of the naturally-occurring volatile flavoring constituents obtained from the fresh juice, by a process developed at the E.U.R.B. *(1, 2)*.

[e] Promset 831-X made by Mid-States Gummed Paper Co.

[f] Desiccite 30 made by Filtrol Corp.

[g] Mention of this product does not imply recommendation by the USDA over similar products not mentioned.

TABLE 1

Taste panel ratings for storage tests Nos. 1 and 2, powdered grape juice product—no predesiccation used

Storage test No.	Type of pack	% Moisture as canned	Storage Temp., ° F.	Taste panel rating after storage period of (months)							
				1	2	3	4	5	6	7	12
1	Vac.[h]	3.2	0	Taken as "standard 8"							
	Air	3.2	100		7.6		6.6		5.9	5.5	
	Vac.	3.2	100		7.0		6.7		5.8	5.5	
	Air	3.2	73		7.9		7.8		7.7	7.7	7.5
	Vac.	3.2	73		7.9		7.9		7.7	7.7	7.5
2	Nit.[i]	3.0	0	Taken as "standard 8"							
	Air	3.0	100		6.2	6.2		6.4			5.8
	Nit.	3.0	100		6.7	6.6		6.5			5.8
	Air	3.0	73		7.9	8.0		7.4			7.7
	Nit.	3.0	73		7.9	8.0		7.5			7.7

[h] Vac. = 27" vacuum
[i] Nit. = nitrogen pack by exhausting to 27" vacuum then filling back to atmospheric pressure with nitrogen gas before sealing.

For taste evaluation the samples were reconstituted with water to a standard Brix; 12.5° for apple and 14.5° for grape. Tasting was done by a panel consisting of from 5 to 10 experienced tasters. These individuals were selected for their familiarity with the juices and for their consistency and acuity in tasting as measured by their ability to detect identical samples in a series of unknowns and the proximity of their rating to the panel average. In each taste test, two to four samples were compared with a control sample. Samples were rated using a scale of 5 to 9, with a rating of 8 assigned to the "standard" (control sample) and a rating of 6 denoting the "limit of acceptability." It is recognized that even a large panel, however skilled, cannot dependably predict the market acceptability of a product. The term acceptable used here means that the reconstituted product still possessed the characteristic fruit flavor as found in the control sample and had not developed to any marked degree "foreign" flavors not present in the control. In many of the taste tests a duplicate sample was included to check the tasters' accuracy. The scores of any tasters who did not assign identical ratings to the duplicates (within narrow limits) on any one test were not used in computing the average sample ratings for that test.

Color of the reconstituted juices was not specifically recorded, but it was noted that any serious change in color, such as browning of the grape, was accompanied by marked flavor deterioration. Caking of the powders was observed on emptying the cans and recorded by a descriptive term such as "in part loosely caked," "free flowing," "tightly caked," etc.

A small sample was taken as soon as the can was opened for moisture determination by the Karl Fischer method.

Three separate storage tests were made with the grape juice powder and one with the apple powder. All cans contained inpackaged desiccant. Test Nos. 1 and 2 were designed to show the effects of packaging the powdered grape product with air, nitrogen and vacuum without any in-the-can predesiccation period. In Test No. 3 various predesiccation conditions preceded storage of the grape product at 100° F. Predesiccation before storage at 100° F. was used in the test with the apple juice product.

RESULTS

It was found that both the apple and the grape juice products retain acceptable flavor for 6 months at 100° F. or for over a year at 73° F. and remain essentially free-flowing; provided that the moisture content of the powders is below certain limits.

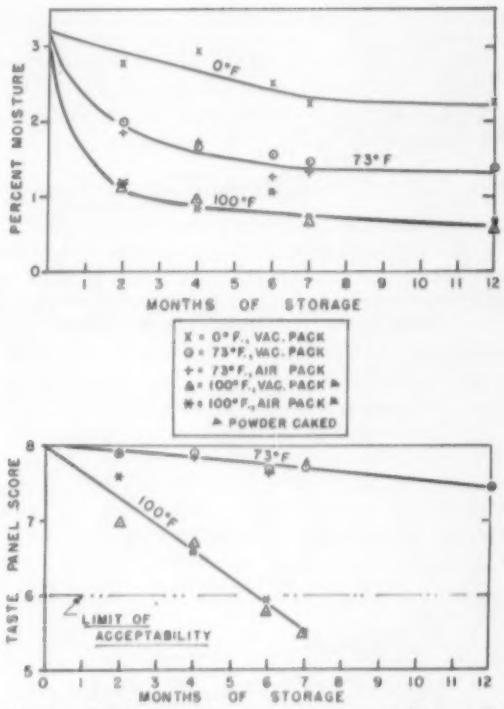


Figure 1. Storage Test No. 1, powdered grape juice product. Changes of moisture content and taste panel score with storage.

Apple and grape juice powders (with an inpackage desiccant) stored satisfactorily as regards caking and flavor at 73° F when their moisture contents as canned were 2.9% and 2.5% respectively. (The exact moisture contents above which caking at 73° F. becomes serious were not determined.) At 100° F. these same moisture levels were found satisfactory for flavor retention. However, at these moistures the products soon agglomerated into practically a single hard lump. To prevent such caking it was necessary to reduce the moisture by inpackage *pre*desicca-

TABLE 2

Taste panel ratings for storage test No. 3, powdered grape juice product,[1] using predesiccation

Predesiccation		Storage temp., ° F.	Taste panel ratings after storage for a period of (weeks)						
Time, wks.	Temp., ° F.		4	6	8	12	15	16	26
0	—	100		6.9			6.9		7.1
4	35	100		7.1			7.1		7.3
8	35	100		7.3			7.3		7.2
12	35	100		7.5			7.1		6.8
16	35	100		7.6			7.2		7.0
4	73	100		7.3			7.2		7.1
8	73	100		7.3			7.2		7.0
12	73	100		7.7			7.1		6.9
16	73	100		7.4			7.2		6.9
—	—	35	7.9		7.8	7.9		7.8	
—	—	73	7.7		7.6	7.7		7.5	7.6

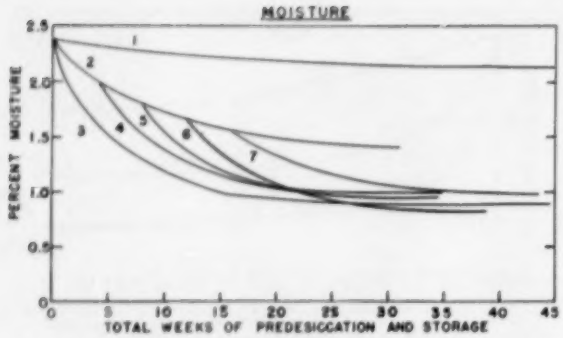
[1] Moisture content when canned was 2.4%; all cans packed at 27 inch vacuum. Control cans (Standard 8) stored at 0° F.

TABLE 3

Taste panel ratings for storage test No. 4, powdered apple juice product,[1] using predesiccation

Predesiccation		Storage temp., ° F.	Taste panel rating after storage for a period of (weeks)							
Time, wks.	Temp., ° F.		4	6	8	12	15	16	26	66
0	—	100		7.4			7.3		7.1	
4	73	100		7.4			7.2		7.3	
8	73	100		7.5			7.3		7.5	
12	73	100		7.3			7.2		7.1	
16	73	100		7.5			7.1		7.0	
—	—	73	7.6		7.7	7.6		7.6	7.6	7.7

[1] Moisture content when canned = 2.8%; all cans packed at 27 inch vacuum. Control cans (Standard 8) held at 0° F.



CURVE NO.	PREDESICCATION TIME AT 73°F., WKS.	STORAGE TEMP.,°F.
1	0	0
2	0	73
3	0	100*
4	4	100*
5	8	100*
6	12	100
7	16	100

*POWDER CAKED

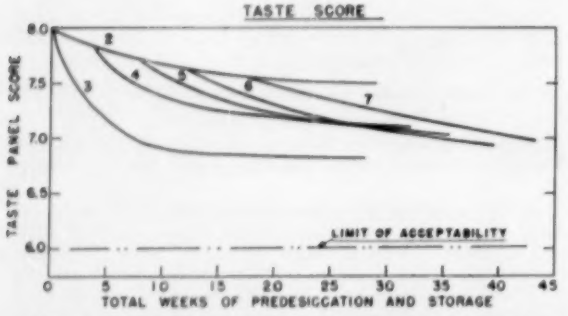


Figure 2. Storage Test No. 3, powdered grape juice product, using inpackage predesiccation at 73° F. Changes of moisture content and taste panel score with storage time.

tion to about 1.7% for the grape product and 2.0% for the apple product before placing them in 100° F. storage. Reduction in moisture to these levels, from the approximate 2.5% moisture attained in the drying step, was accomplished by storing the canned products for 12 weeks at 73° F. At the reduced moisture levels, such caking as did occur consisted only of a few lumps interspersed among the loose powder. These caused no problem on reconstitution.

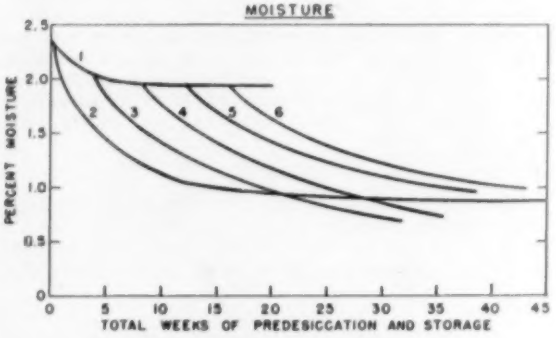
Direct attainment during the vacuum shelf drying operation of the low moisture levels required to forestall caking at 100° F. would have required a substantial increase in drying time over the normal 2½ hour cycle and would have resulted in appreciable heat damage to the flavor. Inpackage predesiccation in 4-ounce cans before storing at 100° F. is a practical method of attaining the very low moistures required *(4,5,7)*.

DISCUSSION

Tables 1, 2 and 3 give the taste panel results; Figures 1, 2, 3, and 4 present graphically both taste panel and moisture data. Except for Figure 1 the actual points have been omittted from the graphs to present a clearer, less cluttered picture. Figure 1 (Storage Test No. 1) presents moisture and taste data obtained in a typical storage test where inpackage predesiccation before storing at 100° F. was not used. Initial moisture content of the powder in this test (No. 1) was high and at 100° F. deterioration was rapid. Air and vacuum packs showed almost identical results. Caking was severe at 100° F. and significant at 73° F.

Storage Test No. 2, made to determine the effect of nitrogen pack, showed similar results in taste score to Test No. 1 (see Table 1). In both tests powder at 73° F. maintained a high score for 12 months. Packaging under nitrogen showed no improvement over atmospheric pack during one year at 73° F. At 100° F. nitrogen pack showed a slight initial superiority. Caking behavior in this storage test was the same as that in Storage Test No. 1.

Figures 2 and 3 show the results of Storage Test No. 3, powdered grape juice product, where inpackage predesiccation at 73° F. (Figure 2) and at 35° F. (Figure 3) was used before storing at 100° F. The inpackage predesiccation improved flavor stability during 100° F. storage, although even the non-predesiccated samples maintained appreciably better flavor at 100° F. than did the comparable samples in the earlier two storage tests. This latter fact is ascribed to the lower initial moisture content in Test No. 3. However, non-predesiccated samples stored at 100° F. in Test No. 3 were badly caked. Thus, predesiccation is necessary for 100° F. storage. In the samples stored at 73° F. and at 35° F. caking was negligible.



CURVE NO.	PREDESICCATION TIME AT 35°F., WKS.	STORAGE TEMP.,°F.
1	0	35
2	0	100*
3	4	100*
4	8	100*
5	12	100
6	16	100

*POWDER CAKED

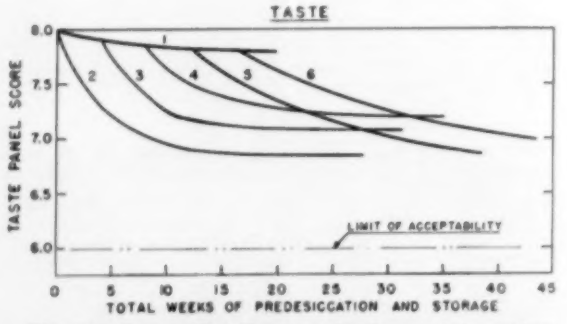
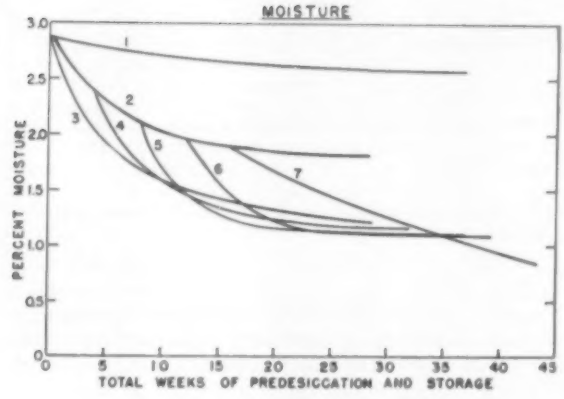


Figure 3. Storage Test No. 3, powdered grape juice product, using inpackage predesiccation at 35° F. Changes of moisture content and taste panel score with storage time.



CURVE NO	PREDESICCATION TIME AT 73°F., WKS.	STORAGE TEMP., °F.
1	0	0
2	0	73
3	0	100*
4	4	100*
5	8	100*
6	12	100
7	16	100

*POWDER CAKED

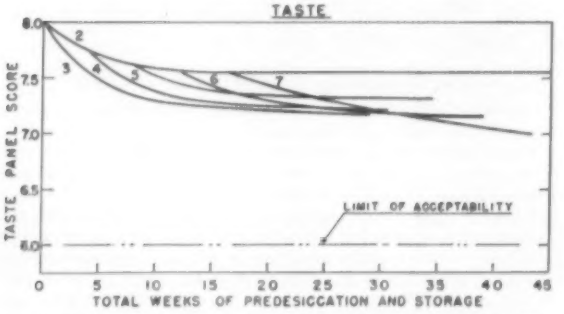


Figure 4. Storage Test No. 4, powdered apple juice product, using inpackage predesiccation at 73° F. Changes of moisture content and taste panel score with storage time.

From Figures 2 and 3 it can be seen that predesiccation at 73° F. proceeds much faster than at 35° F. Since the former is more economical and since the slightly higher flavor deterioration at 73° F. compared with 35° F. is soon offset at 100° F. storage, in-the-can predesiccation at 73° is preferable.

Figure 4 and Table 3 give moisture and taste results of Storage Test No. 4, powdered apple juice product, using inpackage predesiccation at 73° F. All of the samples stored at 100° F. in this test maintained very good flavor. Thus for apple, the use of inpackage predesiccation before storing at 100° F. is not required for flavor stability, but is necessary to prevent caking. At 73° F. caking of the apple powder was insignificant.

SUMMARY

Powdered apple and grape juice products have demonstrated in extensive storage tests that they will store satisfactorily for at least one year at 73° F. and for at least 6 months at 100° F., when packed in 4-ounce cans containing a desiccant envelope.

Moisture content of the powders is an important factor affecting their storage stability. For satisfactory storage at 73° F., moisture content when canned may be at least as high as 2.9% for the apple and 2.5% for the grape. (The exact upper limits were not determined.) For satisfactory storage at 100° F. without caking, moisture content when placed at 100° F. should be 2.0% or less for apple and 1.7% or less for grape. These lower moistures can be attained by storing the powders after canning for 12 weeks at 73° F. with an inpackaged desiccant.

No significant differences in storage stability were found when the powders were packed in air, nitrogen or under vacuum.

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Protective Packaging of Foods Against Moisture Condensation[a,b,c]

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Effects of condensation on corrugated cartons, the glue used for closure, labels, and can surface were observed when canned vegetables were packed in cartons of 26 constructions and removed from 32° F. and 75% relative humidity to 70° F. and 95% r. h. Condensation on most of the packages caused carton fatigue, weakening of the glue, wrinkling and staining of labels, and rusting of cans. But perfect protection was obtained by the use of cartons with aluminum foil on the inside and outside surfaces, with corrugated pads on top and bottom of the cans, and cartons closed by glue plus the use of six strips of waterproof tape. Can rusting was related to the temperature and occurred only in the presence of water in the liquid phase. It was found that a mixture of methylene blue (one part) and talcum powder (20 parts) dusted on the surfaces to be studied was an effective means of detecting and estimating the amount of condensation.

Moisture condensation, the change of water vapor in the air from a gaseous to liquid state, occurs when the atmosphere at a given point becomes saturated with water vapor and reaches the dew point. Lowering the temperature or a sudden transfer of refrigerated products to a warmer atmosphere causes condensation on the surface. Condensation also occurs when warm air is admitted into a refrigerated room and comes in contact with chilled products, or when the water vapor in the room is suddenly raised, as by the admission of steam. Water vapor tends to equalize in all directions, and creates a vapor pressure independent of air circulation. The difference in vapor pressure at a cold surface and at some distance away causes condensation to continue until a temperature (vapor pressure) equilibrium is reached.

Condensation on products or containers may result in rusting of tin cans, dissolving of glue and ink, wrinkling of labels, molding of products, e.g., nuts or dried fruits, sugar blooming of chocolate candies, and the weakening or molding of fiberboard containers. The condensate may (a) collect on an outer surface on a moisture-vapor barrier and run off (as rain on a raincoat) without damaging the package or contents; (b) penetrate and weaken the package, and possibly injure the product (as occurs when a case of canned salmon is left in the dew); (c) penetrate the outer package and be intercepted by a desiccant or absorbent without injury to the product; or (d) evaporate, if the relative humidity is low and the air is well circulated. The first three of these may be corrected, in part, by protective packaging; the last must be controlled by changing the environment.

Moisture condensation and its effect have been partially solved for military rations by protective packaging —that is, using V-board cartons, protective coatings on tin cans, and certain absorptive packaging materials. Protection was obtained for candies by packaging them in boxes containing absorptive materials on the inside and overwrapping with moistureproof film.

Much of the research on preventing condensation on food items has been concentrated on tin cans, and the correction has largely been accomplished by the use of rust-proof coatings. The purpose of this study was to determine the nature of moisture condensation on tin cans, fiberboard containers, glass jars, flexible containers, and certain products, as nuts, dried fruits, and candies. Measures to control condensation by protective packaging were also determined.

CASE HISTORIES OF RUSTING OF CANS

Following are a few case histories of moisture condensation and rusting of tin cans in commercial storage.

Concentrated orange juice (frozen). Rusting of cans when 93,000 cases of six-ounce cans of pasteurized, concentrated orange juice were (a) stored for 2 weeks in Florida at —5° F., (b) then shipped in refrigerated railway cars at 22°-32°, to an east coast city is reported. About 63,350 cases were warehoused at 32°-34°; after 6 months cans in 33,000 cases were found to be rusty, 15,000 cases of which were unsalable. Some of the shipment (30,237 cases) was warehoused at 0° F. with no damage to the cans.

Examination of the product stored at 32°-34° showed that (a) the cases in the interior of the stacks were wet or damp and in some instances were moldy on the outside; (b) a greenish imprint of the ends of cans on the outside of the cases indicated rusty cans on the inside; (c) rusting was worse on cans in the corners of the cases; (d) rust was much worse around the rims, and on top of the cans. The cost of removing rust and repackaging 17,000 cases of this product was estimated at $6,000; more than 1,000 additional cans of the product were unsalable.

Canned sweet potatoes. About 15,000 unsealed cases of unlabeled canned sweet potatoes were stored in a warehouse in which the temperature went to 35° F. at night and rose to about 70° during the day. Opening the doors during the day admitted sufficient warm air to cause condensation and rust on cans throughout the pile, especially those on the top layers of cases on top of the stacks. After inspection of all the cans, about 700 were rejected, with an estimated cost of labor and materials of $633. The condition causing rusting was corrected by the use of unit blower heaters near the ceiling of the warehouse.

Peanut butter. Peanut butter for military use was packed in No. 10 tin cans at 160°-170° F. and 6 of these were sealed in V-type, moisture-resistant cartons with sleeves and metal straps. The product was manufactured and loaded in a south Georgia town on a warm, rainy day and placed immediately in bunker-type refrigerator cars (no ice was used) and sealed. The cars were shipped to Seattle, Washington, requiring 10 days in transit. When unloaded, a large part of the shipment was rejected because of rusting of the cans, especially those in cases on the top of the pile, and adjacent to the wall of the car. The metal straps around the cases in these positions were rusty also. Rust

[a] Presented before the Fifteenth Annual Meeting of the Institute of Food Technologists, Columbus, Ohio, June 14, 1955.

[b] Research in cooperation with The Refrigeration Research Foundation, American Society of Refrigerating Engineers, and published as Technical Paper No. 286, Journal Series, Georgia Experiment Station.

[c] Carl Kayan, Columbia University, and M. L. Williams assisted in collecting the data.

was much worse on the tops and sides of the cans, particularly on the sides of the cans adjuacent to the carton wall. The shipment was acceptable after the rust was removed and the cans repainted, at a rather heavy expense.

Evaporated milk. Rust and mold occurred on evaporated milk cans and labels produced and packaged in Holland for export to the Far East. The damage showed up in the area of Thailand; it was due to condensation rather than the direct action of sea water or other corrosive agents. Forty-eight 14-ounce cans were packed in two layers in wood boxes. Paperboard pads were placed on the bottom and top, and between the layers of cans. Although a water-soluble, vegetable glue was used for pasting the labels together, it was believed that the damaging moisture occurred from condensation when the cases were suddenly exposed to temperatures above that of the tins of milk. The condensate formed on the surface of the tins, and was absorbed by the labels, cardboard sheets, and wooden boxes. Rusting was worse along the can seams. The moisture "rendered the labels patchy, rusty, and mean looking, and offered good conditions for mold growth."

Canned green beans. Another instance of rusting of cans occurred when canned green beans were packed in commercial cases and later transferred to V-board cases for shipment to a military camp. Many of the cans rusted during shipment and early storage apparently due to condensation of moisture entrapped inside the container.

Salted peanuts. An example of filled cans picking up hygroscopic, corrosive substances which absorbed moisture during processing is cited. Grains of salt adhered to the outside of cans of salted peanuts and caused the cans to rust. The salt was picked up by the cans from conveyor belts and other equipment in a processing plant in Virginia. Several weeks later a shipment of salted peanuts arrived in the Philippines, with rusty areas on the cans a little larger than grains of salt.

Empty cans. An example of empty cans sweating and rusting in transit and storage can be cited. A shipment of several cars of No. 1 and No. 3 cans was loaded and sealed in an eastern city in January, with the temperature near 0° F., and unloaded in Cincinnati 4 days later, with outside air 40° to 50° F. Moisture condensed on the inside and outside of the cans and caused rusting shortly after the cans were stored.

Another example of condensation on empty cans occurred when the door of a car loaded with cans was left open at night allowing them to become chilled. Warm air entering the car the next morning caused sweating and rusting of the cans.

Analysis of conditions causing rust. From a study of conditions in warehouses where rusting occurred, the following conclusions were drawn: (a) Rusting appeared on cans within 24 hours under conditions favorable to its development; (b) cans in common storage rusted more severely in steel or masonry buildings than in wooden or insulated warehouses; (c) rusting was worst in the spring or fall months when the temperatures ranged near frost at night, and near 70° during the day; (d) rusting was greatly reduced by air circulation within the storage room, and largely eliminated by the use of ceiling blower-heaters; (e) storing cans in a humid atmosphere or near leaking steam pipes caused rusting; (f) the presence of hygroscopic, corrosive material (salt) on the cans caused rusting.

REVIEW OF LITERATURE

Rose and Johnson *(15)* found that condensation and rusting occurred in 48 hours when the temperature gap between cans and a warmer room was 20° F. at 85% relative humidity. Condensation increased with increased spread between the temperature of the stored cans and the warmer temperature to which the cans were moved. Cartons became damp one or two days after removal from 15° to 60°, 31° to 70°, 50° to 80° F., or any change of 30° F. or more. Cartons were unaffected by a change of temperature of 16° F. or less.

The greatest amount of rust was on the tops of the bottom layer of cans. Under conditions favorable for condensation the cans became wet and rusty, and the labels wrinkled within 24 hours. In 10 days rust stain appeared through the labels. Cartons with labeled cans were damper than those with unlabeled cans. Enameled cans rusted only on the rims and on unenameled seams. The investigators conclude that cans must be removed from refrigerated temperatures gradually—10 to 15° F. rise for each one to two days until the desired temperature is reached.

Smith *et al. (16)* reported that corrosion occurred when cans were packed too damp or too cold, resulting in more moisture than the cartons were able to absorb. Cans should be cased while sufficiently hot (100-105° F.) to insure evaporation of residual cooling water, or allowed to thoroughly cool and dry in open stacks prior to casing. They found that the presence of syrup or certain salts on the outside of cans, resulting from improper rinsing, caused rusting.

Beall and Cassady *(6)* found that cycle freezing and thawing of cans of military rations failed to produce rusting. Postcoating was more resistant to rusting than precoating, but either procedure furnished more rust resistance than plain hot dip plating of cans. Of 5 storage conditions typifying worldwide climates, only those in the tropical Panama Canal Zone caused rusting; corrosion was initiated largely by excreta of insects on the cans.

Murphy *et al. (12)* found that the type of product influenced the rate of heat transfer and condensation. Orange juice was 37.8% thawed while water was 21.2% thawed under identical conditions. The color of the carton, curiously enough, also influenced the rate of thawing. Under identical environmental conditions, the percentage of thawing of water in cartons of different colors were: aluminum foil, 52.5%; aluminum paint, 61.4%; black enamel, 73.4%; white flat paint, 76.7%; and untreated jute, 73.7%.

In an attempt to determine factors that cause rust during shipment by sea, canned peaches were loaded in various ways and shipped by regular steamer from San Francisco to New York (22 days) and return *(4)*. Unlabeled cans, not pre-cooled, packed in wood boxes, or fiber cases, showed 825 perfect cans per thousand, and the remainder slightly rusty. Unlabeled cans, pre-cooled to 36° F. before loading, showed 470 perfect cans per thousand. Cans labeled, pre-cooled to 36° F., with 3 sheets of paper between layers of cans (as pads) to absorb moisture, showed 710 perfect cans per thousand. Cans pre-cooled to 36° F., labeled, with 3 layers of paper between cans (as partitions) showed 563 perfect cans per thousand. Rust was confined to the rim of the cans, and there was more rust in the bottom layer due to moisture running down the sides of the cans.

Contributing to the control of the problem of condensation, Haugh *(10)* prepared a nomograph making the maximum allowable relative humidity easy to find by connecting points on scales for (a) cooler room temperature, (b) transfer room temperature, and (c) maximum allowable relative humidity. This useful nomograph provides a means of adjusting the temperature of either room or the humidity of the warmer room to avoid moisture pick-up.

Dougherty *(8)* related instances of moisture condensation of ship cargo while moving southwards into warmer climate. He furnished a useful distinction; namely, moisture condensed on cargo was identified as "commodity sweat"; that on the hull and ship fittings, "ship's sweat."

Wilkes *(17)* found that corrugated kraft or asbestos paper (⅛-inch thick) coated on both sides with aluminum foil (.0005-inch thick) had a remarkable reflective insulating value. Radiation was dependent on the position and thickness of the air spaces and direction of heat flow. Mason *(11)* showed that aluminum foils with corrugated separators were superior to crumpled foils, but were inferior to plain air-cell type insulation.

It has been found *(1)* that water vapor moves by diffusion from points of high temperature and vapor pressure to zones of lower temperature and vapor pressure. This movement is independent of air circulation and at 32° F., and has a speed in excess of 1,300 miles per hour. Water vapor may even pass through materials that are effective air barriers such as wood, bricks, many boards, and paints. Condensation occurs when the air becomes saturated, and water vapor, as a result of lowered temperature, changes to the liquid state.

Many measures of control have been suggested. Elsworth *(9)* stressed the importance of keeping the temperature of the cans above the dew point by (a) warehouse heating, (b) keeping doors of cool warehouses closed on warm days, (c) avoiding warm humid air entering refrigerated warehouses and (d) avoiding sudden movement of cold cans into warm rooms.

Willet and Germain *(18)* and Murray *(13)* listed various other factors that must be guarded against: (a) deposit of rust particles from retorts, trucks or crates on the cans during processing; (b) deposit of salts (sodium chloride, calcium chloride, magnesium chloride, magnesium sulfate) on the cans during water cooling or as dust particles; (c) over-cooling or under-drying cans before casing; (d) storing cans in corrosive atmosphere, as sulfur dioxide fumes, salt spray, or in a room with fermenting pickles or sauerkraut; (e) use of hygroscopic or insufficiently dry labels or cases; (f) abrasion of cans during processing, handling, labeling and casing. Similar cautions have been given by others *(2, 3, 5, 6, 7)*.

Another contribution of great value in control has been the use of desiccants. Calcium oxide (lump, or recalcined lime) packaged in jean-cloth or paper-coated cloth bags or pouches was found especially satisfactory for in-package desiccation *(14)*. Using this material at 10% of package load, moisture in powdered juices or dehydrated vegetables could be reduced to 1%.

EXPERIMENTAL PROCEDURE

Data presented here were obtained from experiments conducted on a pilot plant scale, using—insofar as possible—commercially manufactured products.

The assembly, storage, and warming-up rooms for the products provided spaces of about 1,000 cubic feet each. Temperatures and relative humidities were semi-automatically controlled at 100° F. at 95% r. h.; 100° at 50% r. h.; 70° at 95% r. h.; 70° at 50% r. h.; 50° at 75% r. h.; and 32° F. at 75% r. h. Other temperatures were 80°, 65° F., and relative humidities ranged as low as 30%.

The relative humidities and temperatures were determined with an electric hygrometer,[4] using both T H 2 limited range, and T H 8 full range sensing elements which were either sealed in the carton or placed in the storage room outside the carton. The temperature-relative humidity gradients of many of the closed cartons were recorded while in the storage and warming-up rooms.

Effect of water and water vapor on rusting. To determine if water vapor caused rusting, in the absence of liquid water, 6-ounce cans of water, 80% syrup, and processed concentrated orange juice (with lithographed labels, paper labels, and no labels) were used. The cans were held at 100° F. and 50% r. h. for 3 days; then transferred to 100° F. and 95 to 100% r. h., in such a manner as to avoid condensation by change of temperature. The cans were: (a) immersed in pyrex glass beakers of distilled water and held covered; (b) immersed in distilled water and removed with as much water adhering as possible; (c) atomized with water spray; (d) packed in water-logged carton so as to touch the wet sides; (e) no treatment. The cans were held in a box with rubber gasket and lid, and examined without being disturbed.

Effect of temperature on rusting. This factor was studied by first storing 6-ounce cans of water, 80% syrup, and processed, concentrated orange juice at 0° F. for 4 days. The opened cases were than removed to 70° at 90% r. h. in such a manner as to permit severe condensation to form and remain on the entire surface of each can. The cans were placed in each of 10 wide-mouthed gallon bottles, with a sponge and one-quarter inch of water in the bottom. The lids were sealed with rubber gaskets, and one bottle was placed at each of the following temperatures: 100°, 80°, 70°, 65°, 50°, 40°, 32°, 20°, 0°, and —10° F. Observations were made on the rate and location of rusting without opening the bottles. Two other experiments were run in which each can was sealed inside a pint glass jar.

Methylene blue method for detecting moisture. Moisture on cans was usually detected by the presence of rust; but frequently the moisture dried off quickly, or the temperature was too low for immediate rust formation. At other times, it was desired to measure moisture on the labels, glass jars, or cartons. To detect the presence of traces of moisture on tin cans, glass jars, boards or flexible packages, methylene blue mixed with talcum powder, in the ratio of about 1:20, was dusted on the packages with a powder puff at the time of packaging. Condensation on the cans dissolved the dye and caused blue spots in proportion to the amount of moisture present. Other evidences of condensation were: dissolved glue and wrinkled labels; dissolved adhesive in the corrugated board, causing the board to become streaked and the layers to become separated; rings on the cartons where the bottom and top rims of the cans touched the board; and weakening or "fatigue" of the cartons.

Effect of position of cans in the cartons on condensation. This factor was studied using methylene blue as a means of detecting evidence of moisture. Each can in each carton was numbered from one to 12, as shown in Figure 4, and estimates were made on the amount of condensation. A total of 336 cans in 28 cases, of 26 different constructions were studied.

Condensation on different parts of cans. Condensation was studied in connection with the position of cans in the cartons. After preliminary studies, it was decided that the amount of condensation at 4 locations on labeled and unlabeled cans should be recorded; namely, top, side to carton wall, side opposite carton wall, and bottom. Estimates on the amount of condensation were made at 1344 locations.

Effect of construction of cartons. Most of the cartons used were regular slotted cartons (R. S. C.) 10½ x 13¾ x 4⅞ inches, inside dimensions; they held one layer of 12 No. 2 cans of products. The items were beans and potatoes, turnip greens, evaporated milk, or salmon. The cartons were made by manufacturers who employed commercial corrugated boards, with bursting test of 200. Two weights of aluminum foil, one having a fiber base, were sealed on some of the boards before it was cut and folded into boxes. An asphalt inner liner was incorporated in some of the boards during manufacture. Two coats of white or black, oil base, flat paint were applied to the exterior of some of the cartons. Pads and dividers of both plain and asphalt-lined boards were used. The insulating of the cartons was increased by putting one carton within another, the addition of a liner, or by placing two inches of loose insulation (vermiculite) in the wall between the boards.

The plain tape used was 60-pound kraft, gummed side in (G.S.I.); the waterproof tape was Scotch pressure sensitive aluminum foil No. 425. The flaps of the cartons were glued with a heavy, water-soluble, starch-base glue, applied with a brush.

The general procedures for running tests on the effect of packaging on condensation were: (a) place the open cartons to be tested and cans in an assembly room at 70° F. and 50% relative humidity for one week; (b) coat the entire surface of cans with methylene-blue talcum powder mixture, pack in cartons with alternate cans labeled, close cartons and place in storage room at 32° or 0° F. for one week; (c) remove cartons to warming-up room at 70° F. and 90% r. h. with 2-inch cleats between cartons, and shifting the position each hour for the first five hours; (d) remove cartons to examination room at 70° F. and 50% r. h., where the cartons, glue, labels, and cans were carefully examined for evidence of condensation.

The amount of condensation on each can was estimated by a visual inspection of the amount of blue stain that appeared on the various parts of the cans—top, top double seam, side seam, wiped area, body, bottom, bottom double seam, top union, and bottom union. A record was also kept of the position of each can in the case, whether or not it was labeled, and the amount of stain on the side of the can next to the carton wall and opposite the carton wall.

RESULTS AND DISCUSSION

Following are the results of a series of experiments run to determine the causes of condensation, and its relation to rusting of tin cans, damaging of labels and weakening of cartons. Methods of preventing condensation by protective packaging are suggested.

Water in the liquid phase was necessary for rusting. Tests showed that when 6-ounce cans of water, 80% syrup, and processed, concentrated orange juice were (a) held under water, (b) dipped in water, (c) atomized with water spray, (d) packed in wet cartons, and (e) left dry, only those in contact with liquid water rusted. Held constantly at 100° F. and 95 to

[4] Aminco Dunmore.

TABLE 1

Corrosion on six-ounce cans of concentrated orange juice held at 100° F. and 95-100 percent relative humidity[1]

Treatment of cans	The relative amount of corrosion after (days)							
	⅛	¼	1	2	3	8	20	90
	Rating	*Rating*	*Rating*	*Rating*	*Rating*	*Rating*	*Rating*	*Rating*
Held immersed in distilled water	1	2	3	4	5	10	10	10
Wet by dipping in distilled water	1	2	3	3	4	5	5	5
Wet by water spray	1	1	2	2	3	3	3	3
Wet by contact with wet carton	0	0	1	2	3	3	4	4
None, dry	0	0	0	0	0	0	0	0

[1] Ratings based on scale from 0 (no corrosion) to 10 (completely covered).

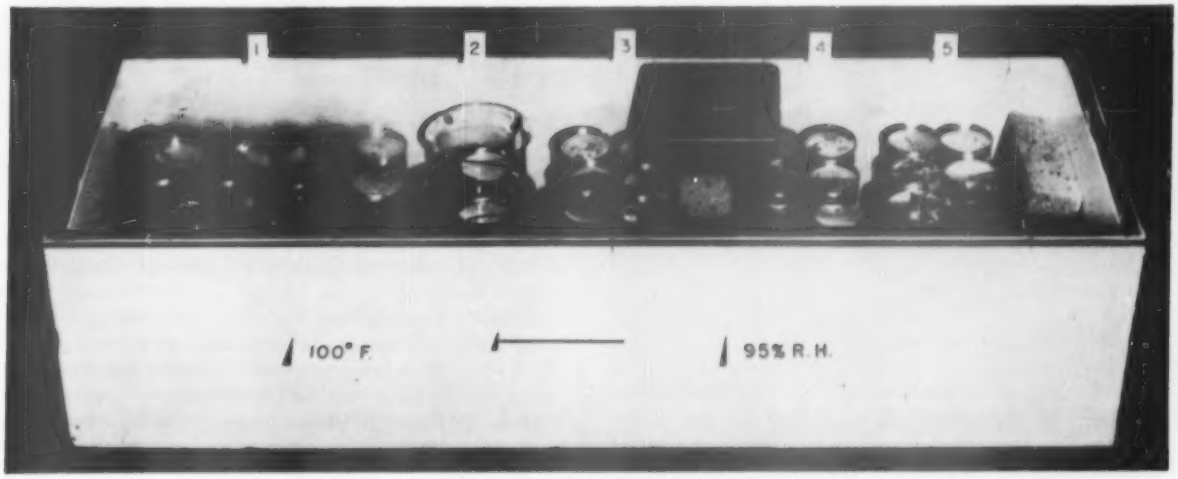

Figure 1. Arrangement for testing the rate of rusting of tin cans, (1) in contact with wet carton; (2) held under water; (3) dipped in water; (4) atomized with water; (5) not wet. Mist on glass lid indicated high humidity.

100% r. h. wet cans began rusting in 4 hours; dry cans held at the same temperature and in an atmosphere practically saturated with moisture vapor, did not rust in 3 months (Table 1 and Figures 1 and 2). Rusting began at practically the same time irrespective of the manner of wetting the cans, and was confined to the areas where droplets of water were present. When the water was removed by evaporation, rusting ceased, even though the relative humidity of the air remained 95% or higher. There were marked differences in the rate of rusting, depending upon the amount of water present. Cans immersed in water rusted worst, those with areas where the water puddled on the cans were almost as bad, and those on which water was atomized (or where the cans were touching the wet board) rusted least.

Density of the contents of a can had no influence on the initiation of rusting; neither did presence of paper or lithographed labels, so long as water droplets were on the exposed metal plate.

Rusting increased with the temperature. Six-ounce cans of water, 80% syrup, and concentrated orange juice which were (a) frozen (b) removed to a room at 70° F. and 95% r. h. to induce condensation (c) sealed in glass jars and (d) stored at 10 temperatures ranging from 100° to —20° F. showed that the rate of rusting was directly related to the temperature (Table 2).

Slight rusting appeared on cans stored at 100°, 80°, and 70° F. with a trace at 65° F. within one day. On the second day the amount of rusting doubled on cans stored at 100°, 80°, and 70° F. but remained about constant at 65° F. The first trace of rust appeared on cans stored at 50° F. on the second day, on cans at 40° F. on the fourth day, and at 32° F. on the sixth day; with no rust on those stored at 20° F. or lower, for a period of 90 days.

Moisture droplets remained on the entire surface of all the cans throughout the experiment. The first rust to appear on cans at all temperatures was on the bottom double seam followed quickly by rust on the top and sides.

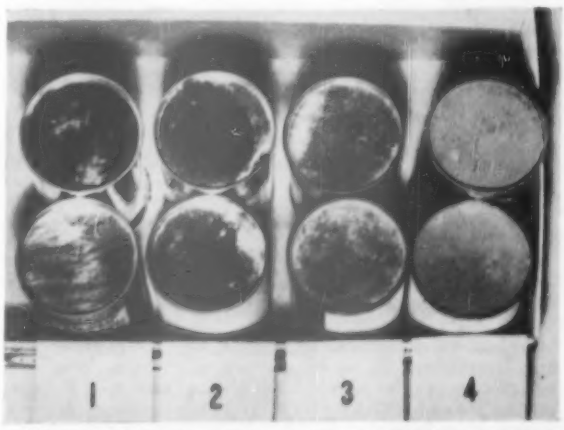

Figure 2. Cans arranged in order of increasing amount of rusting after being, (1) held dry, (2) dipped in water, (3) atomized with water, and (4) held under water.

TABLE 2

Corrosion on tin cans of 80 percent syrup and concentrated orange juice held at temperatures ranging from 100° to 32° F., and 100 percent relative humidity[1]

Storage temperature	Product	Condition of cans after (days)								
		1	2	3	4	5	6	7	8	20
Degrees F.		*Rating*	*Rating*	*Rating*	*Rating*	*Rating*	*Rating*	*Rating*	*Rating*	*Rating*
100	Syrup	.5	1	1	2	2	4	4	5	5
	Orange J.	1	3	4	5	5	6	6	7	8
80	Syrup	.5	1	1	2	2	3	3	3	4
	Orange J.	.5	2	3	4	4	4	4	5	6
70	Syrup	.2	.5	.5	1	1	1	2	3	4
	Orange J.	.5	1	2	3	3	3	3	4	5
65	Syrup	.2	.2	.5	1	1	1	1	1	3
50	Syrup	0	0	0	0	.5	.5	.5	.5	.5
	Orange J.	0	.5	1	1	1	1	1	2	2
40	Syrup	0	0	0	0	0	.5	.5	.5	.5
32	Syrup	0	0	0	0	0	.2	.2	.5	.5
	Orange J.	0	0	0	1	1	1	1	1	1

[1] Rating based on scale from 0 (no corrosion) to 10 (completely covered).

Rusting was slower on cans containing syrup than on those containing water or orange juice. This was apparently due to the presence of a thin, oily film on the syrup cans which protected the surface.

Rate of rusting increased with the temperature for about 30 days, after which time it remained practically constant, due presumably to insufficient oxygen in the sealed jars. The total can surface covered by rust at the end of 30 days was about 90% at 100°, 60% at 80°, 50% at 70°, 30% at 65°, 20% at 50°, 5% at 32°, and none at 20° F. or lower.

Position of cans in carton influenced condensation. In these studies methylene blue was used as an indicator for detecting evidence of moisture condensation on cans. It was found that moisture condensation was (a) heaviest on cans in the center of the carton (positions 6 and 7 in Figures 3, 4, and 5) because these remained cold longest; (b) an average of 8.1% heavier on the side of the cans next to the carton wall than on the opposite side; and (c) 8% less on cans in the corners of cartons than on other outside cans (because the corner cans warmed-up more rapidly and condensation ceased earlier).

There was a tendency for condensation to form first on the side of cans adjacent to the carton wall and to continue until these approached room temperature. Almost immediately, condensation formed on cans on the interior of the carton and continued much longer. Not only did more condensation form on cans near the center of the carton but drying was much slower, both of which resulted in more rusting.

Condensation was heaviest on top and lightest on bottom of cans. Data in Tables 3 and 4 show the relative amount of condensation (as determined from 1344 observations by the methylene blue method) at 4 locations on 336 cans in 28 cases of 26 different constructions. Condensation was heaviest on the top, less on the sides, and least on the bottom. Considerable variation occurred; for example, when condensation was light, practically all of it occurred on top of the cans; and when heavy, it ran over the top seam, down the side, and puddled beneath the cans. In the latter case, it might appear worse on the bottom though it actually formed on top.

There was no consistent difference in the amount of condensation on labeled and unlabeled cans. When it

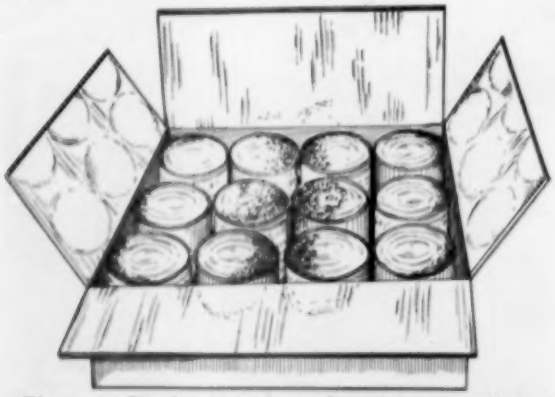

Figure 3. Showing moisture condensation and rusting of cans—most severe on top of cans in center of case not covered by end flaps; and on sides of cans touching case wall. Moisture entered the case through breaks in the vapor barrier, and condensed on the nearest cans. Some of the moisture was absorbed by the carton and formed can rings where it touched the cans. Additional moisture frequently puddled in the bottom of the carton and caused rusty can rings.

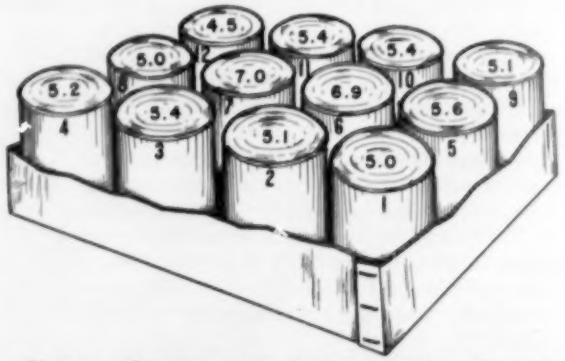

Figure 4. Cut-away carton showing numbering of experimental cans from 1 to 12, based on their position. Numbers on top indicate the average amount of condensation on cans in 28 cases of 26 different constructions.

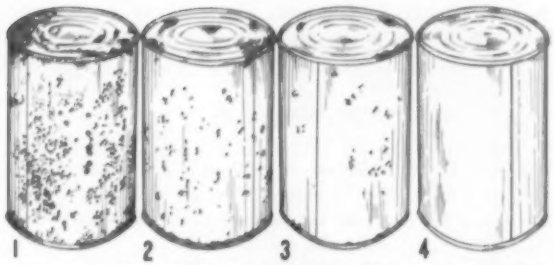

Figure 5. The relative intensity of rusting on cans in Position 6 in cartons of four different constructions.

1. **Very heavy rusting; plain carton closed by gluing flaps in the manner usually done commercially.**
2. **Moderate rusting; carton made of board with asphalt inner liner, closed with glue.**
3. **Slight rusting; carton painted on the outside, closed with six strips of waterproof tape.**
4. **No rusting; carton with aluminum foil on both inside and outside, with pad of plain board on top and bottom of cans, closed with six strips of waterproof tape.**

was light, the labels tended to protect the can surface, but when it was heavy, the labels and glue soaked up water and increased rusting.

The construction of cartons influenced carton "fatigue" and the amount of condensation on tin cans. Data in Table 3 show the results from 26 experiments to determine the influence of the construction and method of closing of cartons on the amount and effects of condensation on No. 2 tin cans of beans and potatoes, when subjected to conditions which normally cause severe damage. The listing is in the approximate order of the *poorest* to the *best* method of construction and closing, to protect the cartons, adhesives, labels and cans against damage from condensation. Variations in construction included the use of asphalt in the inner liner, oil base paint on the outer surface, aluminum foil on the inner and/or outer surface, and increased insulation. Variations in closure included the use of gummed tape, water-soluble glue, and waterproof tape (Figures 7 and 8). Extra walls, pads, and dividers were used as moisture absorbents, and to increase insulation.

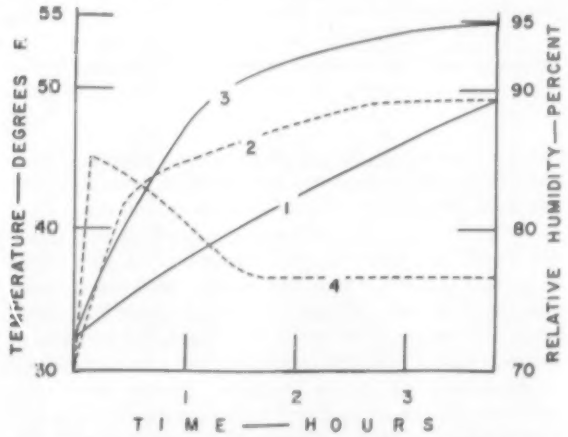

Figure 6. Temperature-relative humidity gradients for the first 3½ hours when salmon in four-ounce cans, and preserves in ten-ounce glasses were moved from 32° and 75 percent r. h. to 70° and 50 percent r. h. (1) and (2) show the temperature and relative humidity in cases of salmon; (3) and (4) show the same for preserves.

Plain Cartons: These cartons were entirely unsatisfactory irrespective of the method of closure or the use of pads. From the data presented, and others not included in Table 3, it was determined that practically all of the moisture which condensed on the cans entered the case due to differences in vapor pressure outside and inside the case. The board itself must resist moisture vapor pressure if condensation is to be avoided, and all cracks, joints and breaks, due to handling or folding must be sealed against the entrance of moisture vapor. Provision must also be made to absorb traces of moisture; for example, greater use should be made of pads, dividers, absorbers or desiccants. Pre-drying the empty carton before assembling is another procedure to be recommended. Closures should brace the cases well and be as snug as possible without acting as a bellows when stacked or handled. Moisture may enter even minute openings in a barrier, condense on any chilled object in its path, and then spread over an unlimited area by "wicking" or capillary action. Complete protection can be, and was, obtained either by hermetically sealing the

Figure 7. The method of closing cartons influenced the resistance to condensation on products. (Left) stapled cartons were well braced but had little resistance to water vapor pressure; (center) cartons above closed with two strips of tape and carton below with six strips; (right) cartons with flaps glued leaving opening near center as shown by arrows.

Figure 8. Condensation controlled by protective packaging. After being subjected to rather severe conditions. (1) plain carton with flaps glued down, resulted in weakened board with can rings, softened glue, and rusty cans; (2) carton with inner and outer layer of aluminum foil, pads above and below the cans, and flaps sealed with waterproof tape, resulted in no injury to carton, glue, labels or cans.

TABLE 3

The influence of carton construction on the amount of damage by condensation to cartons, gluing, labels, and cans [1]

Cartons		Condition when examined [2]							
					Cans				
Construction	Closure	Carton	Gluing	Labels	Top	Side to carton wall	Side opposite carton wall	Bottom	Entire surface
		Rating	*Rating*	*Rating*	*Rating*	*Rating*	*Rating*	*Rating*	*Rating*
Plain	Glued	3	4	7	8.8	7.8	7.0	8.4	8.1
	Glued and 2 strips of gummed tape	5	3	6	9.5	8.4	7.1	8.4	8.3
	Glued and 6 strips of waterproof tape	6	7	7	9.9	9.3	9.8	9.1	9.5
	Same with top and bottom pads	4	4	7	9.3	7.3	7.4	7.5	7.9
Plain carton inside plain carton	6 strips of waterproof tape	5	6	5	9.8	9.4	9.2	8.8	9.3
Same with extra liner	(Same)	4	4	4	9.7	9.1	8.2	9.1	9.0
Same with 2" insulation between walls	(Same)	6	6	6	8.9	9.3	7.6	7.4	7.9
Asphalt in corrugations	Glued	5	4	7	7.3	8.4	6.4	4.6	6.7
	Glued and 2 strips of gummed tape	6	4	8	9.3	8.6	7.3	4.6	7.4
	Glued, top and bottom pads	5	4	6	6.9	8.2	6.5	4.3	6.5
	Glued, 2 strips gummed tape, top and bottom pads	5	4	6	7.7	7.7	5.5	3.0	6.0
Painted	Glued and 6 strips of gummed tape	6	6	4	7.4	5.9	2.5	5.2	5.2
	Glued and 6 strips of waterproof tape	3	4	5	5.6	7.2	6.9	5.9	6.4
Aluminum foil on inside	Glued	3	2	4	5.7	3.9	3.4	3.5	4.2
	Glued and 6 strips of waterproof tape	2	2	3	5.6	5.3	3.4	2.9	4.3
	6 strips waterproof tape	5	5	4	6.9	5.4	6.5	2.2	5.3
	6 strips waterproof tape, top and bottom pads	4	4	2	2.5	5.8	4.7	5.2	4.9
	Glued and 2 strips of waterproof tape	2	1	2	6.2	3.5	3.2	2.3	3.8
Aluminum foil on outside	Glued	2	2	4	5.7	3.7	2.3	4.5	4.0
	6 strips waterproof tape	3	3	3	5.7	6.0	3.2	4.6	5.0
	Glued and 2 strips of waterproof tape	1	1	3	5.7	6.0	3.2	4.6	5.0
Same placed inside plain carton	Similarly as above	2	3	1	2.2	3.4	2.0	2.1	2.5
Aluminum foil inside and outside	Glued	5	4	2	2.1	1.6	1.5	1.4	1.7
	Glued and 2 strips waterproof tape	5	4	1	1.1	0.8	0.7	0.7	0.8
	Glued and 6 strips of waterproof tape	0	0	0	0.5	0	0	0	0.1
	Same with top and bottom pads	0	0	0	0	0	0	0	0

[1] Cases of No. 2 tin cans of vegetables were assembled at 70° F. at 50% relative humidity; stored for one week at 32° at 75% r. h.; warmed-up for one week at 70° at 95% r. h.; and examined at 70° at 50% r. h.

[2] Ratings based on a scale from 0 (no damage) to 10 (severe damage).

containers, or, with slightly less perfect containers, the use of absorbents or desiccants.

All of the plain cartons were in poor condition, with prominent streaks on the outer and inner face showing location of corrugations. The boards were usually damp and weakened, with corroded staples and prominent can rings. The glue between layers of board, between flaps, and on labels was much weakened. The labels showed signs of having been wet, as indicated by partial dissolving of glue, wrinkling, and discoloration over the entire surface. In most cases the tops, top seams, and bottom seams of the cans were severely stained, the sides only lightly stained.

Closing with glue had the advantages of bracing the cartons and affecting a snug seal; but this procedure had the disadvantage that the seams between the flaps and the openings in the corners were not closed. There was no indication that the water added with the glue increased the amount of condensation on the cans.

Use of 2 strips or 6 strips of gummed tape to cover the cracks and holes in glued cases was of only slight advantage since this tape was an extremely poor moisture vapor barrier. Waterproof tape was very effective when used on glued, waterproofed cases, but when used without glue a bellows was produced which increased condensation and carton "fatigue." In the latter case, moisture was entrapped and held beneath the tape and increased the rusting of the cans and wrinkling of labels.

Pads in the bottom and top of the cases, or dividers between the cans, reduced damage through absorption of some of the condensate; but the absorptive capacity of this material was not sufficient to protect the cans

when heavy condensation occurred. A disadvantage to the use of pads and dividers was that they became damp and tended to hold moisture in contact with the cans.

Insulated Cartons. Insulation did not reduce condensation. Data on canned vegetables packed in (a) plain cartons, (b) plain cartons placed inside similar cartons forming a complete double wall, (c) double wall cartons with extra liner forming a triple wall and, (d) double wall carton with 2 inches of loose-fill insulation between the walls showed that insulation did not reduce condensation. As shown in Table 3, the condition of these cartons was rated 5, 5, 4, and 6, respectively; and cans within the cartons were rated, 8.1, 9.3, 9.0, and 7.9, respectively.

Use of double wall and triple wall cartons was slightly beneficial in absorbing condensate; but when additional insulation was used between the double walls, condensation on both the carton and cans increased. The latter technique slowed down the rate of warming, prolonged the period of condensation formation, and caused it to form more evenly over the entire can surface. However, condensation was heaviest where cans touched other cans or the carton wall.

Cartons with Asphalt Corrugations. Asphalt in the inner liner of the board protected the carton from fatigue, but allowed enough moisture to pass through to puddle on the inside of the case beneath the cans. The outer appearance of the cartons, except for corrosion of the staples, was excellent, but the board was damp and easily torn, and had prominent can rings. There was moderate ungluing, wringling, and staining of can labels. Rusting of cans was practically the same as with plain cartons. It was concluded that corrugated, asphalt-impregnated kraft paper was of little value as a moisture vapor barrier, irrespective of the method of closure.

Painted Cartons. Painted cartons gave as good results as did those with aluminum foil on the outside, with the added advantages that the coating did not crack when bent, and was much less subject to scuffing. Complete control of condensation was possible by using a moistureproof paint, top and bottom pads, and closing with glue and 6 strips of waterproof tape.

Cartons with Aluminum Foil on the Inside. Aluminum foil on the inner face of the carton wall was a fairly good moisture barrier and reduced the amount of rusting on the cans, but had the disadvantage that it caused moisture to condense and accumulate in the carton wall and increase carton fatigue. As it was impractical to seal the cracks between the flaps on the inside, the total benefit from this treatment of boards for cartons was slight. There was considerable staining of cans in the corners and center of the cases, and a slight amount on the remainder.

Cartons with Aluminum Foil on the Outside. Extremely good results were obtained from the use of foil on the outside of boards for boxes. The outside foil caused condensate to collect in droplets and run off, or dry off, without penetrating and weakening the board. Thus, carton fatigue was prevented. Disadvantages in the use of this board were that the foil broke or cracked when bent, was easily scuffed during handling, and it was necessary to use glue and 6 strips of waterproof tape to adequately close the cases. Since most of the cases with this treatment had at least one imperfection, it was found advantageous to use pads on the top and bottom of the cans to absorb traces of moisture.

Cartons with Aluminum Foil on the Outside and Inside. Perfect protection was obtained when this type of carton was used with top and bottom pads, and closed with glue and 6 strips of waterproof tape. Damage to cases or contents could be traced to imperfections in the carton or method of closure. When the cartons were closed by gluing only, moisture entered the cracks and spread by "wicking" to all parts of the carton, causing some damage to the carton, gluing, labels and cans.

TABLE 4
Condensation on cans in different positions in cases[1]

Can position in carton	Condensation on cans				
	Top	Side to carton wall	Side opposite carton wall	Bottom	Mean
	Rating	*Rating*	*Rating*	*Rating*	*Rating*
1	5.8	5.9	4.0	4.1	5.0
2	6.1	5.1	4.5	4.8	5.1
3	6.4	6.0	4.8	4.7	5.4
4	6.8	5.7	4.2	4.4	5.2
5	6.2	5.6	5.3	5.0	5.5
6	7.3	....	6.8	6.5	6.9
7	7.6	....	6.9	6.6	7.0
8	6.4	6.0	4.4	3.8	5.0
9	6.3	6.1	4.3	4.4	5.1
10	6.9	6.2	4.5	4.6	5.4
11	6.8	5.9	5.0	4.9	5.4
12	6.2	5.1	4.3	3.5	4.5

[1] Ratings based on scale from 0 (no condensate) to 10 (completely covered).

Temperature-relative humidity gradients useful in studying condensation. A record of changes in temperature and relative humidity within cases of salmon, preserves and other products, after being removed from refrigerated storage, was an aid in evaluating the efficiency of cartons in preventing condensation.

Figure 6 shows 4 curves for temperature and humidity changes in 2 products, for the first 3½ hours after removal from refrigerated storage. Curve 1 shows a gradual increase in temperature inside cases of 4 layers of 4-ounce cans of salmon. Curve 2 shows that the relative humidity in these cases rose rapidly for 24 minutes, continued to rise gradually for 2 hours, then remained constant, resulting in considerable condensation on the cans. Curve 3 shows rapid increase in temperature for 1½ hours then a gradual increase for the next 2 hours inside cases of a single layer of 10-ounce jars of preserves, with dividers between the jars. Curve 4 shows that the relative humidity in these cases rose very rapidly for 6 minutes, dropped gradually for 1½ hours, then remained constant with little or no condensation.

Lack of condensation on the jars of preserves was due to: (a) the presence of dividers between the jars which absorbed the condensate; (b) the small amount of space occupied by the product; (c) the short time that the product temperature remained at or below the dew point; and (d) the fact that the jars were packed only one layer deep in the case.

Temperatures and relative humidities were measured approximately one inch from the cans or jars and for this reason did not correctly represent conditions on

the surface. Consequently, condensation sometimes occurred on the containers (cans or jars) without the relative humidity as measured, reaching 100%.

SUMMARY

Experiments in which labeled and unlabeled tin cans were held immersed in water, dipped in water, atomized with water, packed in wet cartons, and stored dry, at 100° F. and 95 to 100% relative humidity, showed that the presence of water in the liquid phase was necessary for rusting of tin cans.

Rusting of tin cans increased with the temperature. When wet cans were held in an atmosphere saturated with moisture, a trace of rust appeared at 100° and 80° F. in 4 hours; at 70° and 65°, in one day; at 50°, in two days; at 40°, in four days; at 32°, in six days; and at 20° F. or lower, no rust in 90 days. The can surface covered by rust after 30 days was about 90% at 100°, 60% at 80°, 50% at 70°, 30% at 65°, 20% at 50°, 5% at 32°, and none for 20° F. or lower.

A light coating of a mixture of one part methylene blue with 20 parts of talcum powder on the surface of cans, labels, and cartons, was found to be an excellent means of detecting moisture condensation. The dye was barely detectable unless dissolved by moisture which caused it to turn blue.

Under conditions favorable for condensation, it formed first on the side of cans towards the carton wall, but was heaviest on cans in the center of the case. Three factors favorable to moisture condensation on tin cans were: (a) exposure to ingress of vapor from without, (b) proximity to damp carton wall or similar surface, (c) relatively slow warming of product and drying of can surface.

It was found that condensation could be prevented from forming on cans removed from 32° F. to 70° at 95% relative humidity by protective packaging. Features required for such a package were: (a) carton wall made impervious to water vapor by aluminum foil, paint, asphalt, or other materials; (b) flaps glued in place to brace the carton and reduce the bellows effect during handling; (c) openings between flaps, and in corners of carton sealed with waterproof tape; (d) use of pads, dividers, absorbers, or desiccants to remove traces of moisture which might enter the package.

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Effect of Sucrose-Invert and High Conversion Glucose Syrups in the Preparation of Candied Cherries[a,b]

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A study was made of the effect of sucrose-invert sugars alone and also in combination with high conversion glucose syrup on quality of candied cherries. From the standpoint of flavor, texture, and keeping properties, a properly balanced sucrose-invert blend (2:1 to 1:1) was found preferable to any combination containing glucose. The cherries containing sucrose-invert sugar showed the greatest gain in weight. If glucose is used, 20% appears to be the maximum concentration permitting a satisfactory product.

Candied fruit manufacturers commonly use considerable amounts of regular commercial 43° Bé glucose in the candying syrups to control crystallization. Other reasons given for using glucose are its ease of handling, apparent cheapness, moisture retaining properties and

[a] Contribution No. 854 from the Division of Horticulture, Experimental Farms Service, Ottawa, Canada.

[b] Presented at the Fifteenth Annual Meeting of the Institute of Food Technologists, Columbus, Ohio, June 13, 1955.

reduced sweating at high relative humidities. Previous work by the writers *(2)* indicated that glucose could be replaced advantageously by invert sugar. A properly balanced sucrose-invert blend resulted in a product of better flavor and less susceptibility to microbial spoilage.

Recently special high conversion types of glucose have been advocated. The greater degree of conversion results in an increased "dextrose equivalent," reduced viscosity, and improved flavor characteristics. Hence some have thought that this type of glucose blended with sucrose and invert sugar might result in better candied cherries. Therefore a study was made of the effect of sucrose-invert sugars alone and also in combination with high conversion type glucose in the preparation of candied cherries by the hot continuous syruping method. The object was to determine the effect of these "sugars" upon yield, quality, and stability of the finished product.

EXPERIMENTAL PROCEDURE

Samples of standard "brined" cherries *(3)* were leached, dyed, and candied according to this Laboratory's recommended hot continuous syruping method *(4)*. In this candying method the syrup is maintained at 140° F. (60° C.) and cencentrated by evaporation at the rate of about 1% per hour for 8 hours per day. A finished total soluble solids content of 72-73% is attained in the syrup in 6-10 days. The cherries are then usually stored in the finishing syrup for 1-2 weeks at room temperature to assure equalization and maximum gain in weight.

The syrups employed in this study contained (a) Sucrose and invert sugars only in a ratio of sucrose to invert of 2:1 to 1:1. (b) Syrups in which 10, 20, 30 and 50% of the total soluble solids in the sucrose-invert-glucose mixture were derived from high conversion type glucose. Analysis of the high conversion type glucose used in this study compared with the regular type glucose is shown in Table 1. Observations were

TABLE 1

Comparative analysis of high conversion type glucose and regular type glucose

Determination	High conversion glucose	Regular glucose
Baumé	43°	43°
Water	19.9%	19.9%
Dextrose Equivalent	55.0%	42.0%
Dextrose (dry basis)	21.5%	21.5%
Maltose (dry basis)	49.9%	21.0%
Higher sugars (dry basis)	6.7%	20.3%
Dextrin	21.9%	37.2%
Ash	0.05%	0.25%
pH	4.8-5.0	4.8-5.0
SO_2	.001%	0.04-.003%

made as to weight gain, appearance, texture, and flavor of the cherries.

Total soluble solids were determined by refractometer at 68° F. (20° C.). Sugars were estimated by the Lane-Eynon volumetric method *(1)*.

The hygroscopicity tests were carried out at 68° F. (20° C.) employing sulphuric acid to obtain constant humidities *(5)*. Approximately 1000 ml. of sulphuric acid solution of required specific gravity was placed in a 250 mm. diameter desiccator. Five samples each weighing about 35 g. were placed in watch glasses on the perforated porcelain plate in the sealed desiccator. One set of samples was held open to the Laboratory atmosphere at 68-73° F. (20-23° C.) and relative humidity ranging from 20-37%. The gain or loss in weight was recorded after 3 weeks. Observations also were made of appearance, texture, and flavor.

RESULTS AND DISCUSSION

Examination of the cherries immediately after the candying process had been completed showed the lots containing sucrose-invert sugar alone had the best flavor, texture, and appearance. The fruit was well rounded and there was a gain of 10% or more in weight. On the other hand, the 50% glucose samples were severely shrivelled. These cherries failed to gain weight and were of poor appearance, flavor, and texture. The adverse effects varied directly with the glucose content and were more marked in the 6-day than in the 10-day processed fruit. When glucose is used, a slower process is required if undue shrivelling is to be avoided. Twenty percent glucose appeared to be the maximum yielding a satisfactory product. General opinion was that high conversion glucose gave a superior quality product to regular grade glucose. Table 2 presents a summary of the condition of the cherries immediately at the end of the 10-day process.

Hygroscopicity tests (Table 3) showed no practical difference in loss in weight between any of the samples at a relative humidity of 70% or less. Equilibrium was attained at close to 80% relative humidity for all sugar combinations. At very high humidities (94%) the glucose samples showed least gain in weight in direct

TABLE 2

Condition of cherries immediately at end of 10-day process

Glucose content	Weight gain	Appearance, texture and flavor
%	%	
0	11	Plump, excellent texture and flavor
10	9	Fairly plump, good texture and flavor
20	6	Some shrivelling present. Fairly satisfactory texture and flavor. Considered maximum for glucose content
30	2	Considerable shrivelling. Texture and flavor only fair
50	1	Excessive shrivelling. Unsatisfactory for appearance and yield. "Glucose" taste and texture

TABLE 3

Effect of humidity on weight of candied cherries in a 3-week period at 68° F. (20° C.)[1]

Glucose	% Relative humidity					
	20-37 (Room)	18.8	37.1	70.4	80.5	93.9
	% loss − or gain + in weight					
	%	%	%	%	%	%
0	−15.9	−13.3	−12.8	−3.0	+2.2	+13.3
10	−16.1	−13.7	−13.5	−4.9	+0.4	+12.5
20	−15.4	−14.0	−13.0	−4.0	+1.4	+11.9
30	−16.0	−14.1	−13.4	−5.5	+0.3	+9.6
50	−15.4	−12.4	−12.4	−5.8	+0.2	+8.4

[1] Total soluble solids concentration 72-73%. Ratio of sucrose to invert sugar 2:1 to 1:1.

proportion to their glucose content. Ratio of sucrose to invert sugar in all cases fell within the range of 2:1 to 1:1. This variation did not materially influence the relative humidity effects.

At low relative humidities, e.g. less than 40%, cherries prepared in 30 and 50% glucose content syrup became very hard on 3-weeks exposure. Under similar conditions fruit containing sucrose-invert sugars alone

retained a very desirable texture. Exposure to air movement in the room as would be expected caused greater weight loss and changes in quality of the fruit than under similar static relative humidity temperature conditions. None of the lots at any of the relative humidities used showed crystallization in the 3-week period.

At 93.9% relative humidity the cherries in all samples became wet with free syrup accumulation on 3 weeks' exposure. The 30% and 50% glucose lots showed the least free liquid. Every lot molded.

From these studies it would appear that glucose might be of some advantage only under very humid conditions that are seldom encountered in practice. With few exceptions excessive drying of the product is a problem once the package has been opened. Previous studies at this Laboratory have indicated that a small percentage, e.g. 15-30%, glucose in candied fruit tended to prevent crystallization when improper sucrose-invert sugar concentrations occurred. However, high glucose content fruit also tended to be more subject to microbial spoilage due to the lower true sugar content. In this current study fruit of 72.5% total soluble solids contained in the case of sucrose-invert sugar mixtures alone 75% sugar as invert. The 20% glucose content fruit contained 69% sugar as invert and the 50% glucose content fruit contained only about 59% sugar as invert. With regular commercial glucose the actual sugar content would be even less as shown previously by the writers *(2)*.

SUMMARY

An investigation was made of the effect of sucrose-invert sugars alone and also in combination with high conversion glucose on the quality and keeping properties of candied cherries. The fruit was candied by the hot continuous evaporation method to a total soluble solids content of 72-73%. In all cases the ratio of sucrose to invert sugar in the syrup was maintained within the range of 2:1 to 1:1. Where glucose was employed it constituted 10, 20, 30, and 50% of the total soluble solids.

The cherries containing sucrose and invert sugars only resulted in the best quality with the most satisfactory keeping properties under most conditions. They showed the greatest gain in weight. As the glucose content increased the percent weight gain decreased. If glucose was used, 20% concentration was considered the maximum permitting a satisfactory product.

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Notes and Letters

Recent Developments in the Potato Flake Process[a]

In an earlier paper *(1)* the authors described the process for making a new form of dehydrated mashed potato, potato flakes, by the use of a double drum drier. Basically simple, the process begins with the normal peeling, trimming and slicing operations. A pre-cooking step, the newly discovered method of control of texture is then introduced if desired, after which the slices are finally cooked, usually in steam. The cooked slices are mashed immediately and diluted with a small amount of hot water to adjust the solids content and thereby improve adherence to the rolls of the drier. Sulphite salts or other additives may be easily incorporated during this step. The mash is applied to the drums and dehydrated under conditions of temperature, time and roll clearance to yield a product of excellent quality at the required dryness. The product is recovered from each drum as a thin continuous sheet of controlled thickness, which is then broken and screened to yield flakes of the desired size.

Potato flakes have excellent appearance and flavor. The development of off flavors due to holding periods or prolonged heating is minimized because the potatoes are ready for drying immediately after mashing and the dehydration is accomplished in less than half a minute after application of the mash to the drier drums. A desirable baked potato flavor is imparted during the short dehydration.

Good appearance and flavor are essential requirements in a mashed potato but they are less difficult to achieve in a dehydrated product than the most important attribute—good texture. A desirable product is one which has texture as near that of freshly mashed potato as possible—mealy, but not lumpy, and particularly, not pasty or gummy. By avoiding cell rupture, both during manufacturing and during rehydration, the release of free starch and resulting pastiness is kept at a minimum. However, a low solids potato, even though processed with little cell damage, will still not yield an

[a] A novel approach to the control of texture in dehydrated potatoes was disclosed in a paper presented at the IFT meeting at Columbus by a research team of chemical engineers at the Eastern Regional Research Laboratory of the U. S. Department of Agriculture. The process will be described in detail in an Agricultural Research Service publication "Potato Flakes. A New Form of Dehydrated Mashed Potatoes. II. Some Factors Influencing Texture." by J. Cording, Jr., M. J. Willard, Jr., R. K. Eskew, P. W. Edwards, and J. F. Sullivan.

acceptable mashed potato texture due to the insufficient amount of starch contained in the potato cells.

Procedure. The development of the precooking step now permits the dehydration of potatoes of lower solids content to yield a product of acceptable texture. In fact, by the use of the two-stage cooking method, the texture of mashed potatoes reconstituted from potato flakes can be varied as desired from smooth, through mealy, to excessively grainy. The method consists of a precook at a temperature high enough to gelatinize the starch, preferably in the range from 150° F. to 165° F., followed by a final cook at 212° F. The 5/8 inch thick raw slices usually require from 15 to 30 minutes precooking in either water or steam-air mixture followed by a final cook in atmospheric steam of about 16 minutes.

After the precooking treatment, the slices are no longer crisp, as when raw, but are tougher, resilient, and somewhat translucent. After the final cooking in steam, the slices are still tougher than those not precooked and when mashed yield a drier appearing, more mealy mash. The exact choice of conditions are determined by the type potato being processed and the texture desired in the reconstituted product. In general, the lower the precooking temperature (within the 150°-165° F. range) the more mealy the resulting product. Also, as the precooking time is increased, the effect becomes more apparent. Experimental work has shown that some combinations of temperature (below 150° F.) and time (above 1 hr.) produce too large a particle size in the mash to give an acceptable product.

Factors influencing texture. While an understanding of the effects of precooking on product texture has been gained, further work is required to explain them. Studies as to the nature of the changes taking place are in progress. Most investigations so far indicate that a modification of the starch within the cell resulting in an increased swelling power is the main factor. One fact which bears out this premise is the increased amount of liquid necessary for rehydration of flakes made by precooking to produce a typical mash. Previously 4.5 parts of rehydrating liquid for one part of flakes were used; now ratios of 5.0:1 are normal and even 5.25:1 may be required.

Other variables in the flake process that are closely controlled to guard the texture of the final product are based on the avoidance of cell rupture and release of free starch. For example, the roll clearance has been found to be optimum in the range that produces films of substantially monocellular thickness. If the clearance is too small the individual potato cells are crushed and the flake reconstitutes to a pasty product. If the clearance is too large the cells adhere in agglomerates, resulting in a product of high moisture content which may also be lumpy. In practice, a flake thickness of 0.005 inches to 0.009 inches produced with a drum clearance of about 0.007 inches to 0.010 inches is preferred.

Dilution of high solids content mashed potato prior to drying results in several improvements in the product. Among these are higher flake density and a higher resistance to shattering during breaking to the desired size. Both density and strength have optimum values when the adjusted solids content is about 20%. This controlled dilution also results in the production of flakes of lower moisture content because of better adherence of the mash to the drums and consequent better drying efficiency. Flake moisture is normally maintained between 3 and 4%.

Success with the double drum drier indicates the possibility of using the single drum drier which employs a series of spreader rolls to apply the mash.

With this equipment, long familiar to the potato flour industry, it may be possible to increase production rates and product density. The results from tests on this type drier as well as processing costs and storage characteristics of the double drum process will be published when completed.

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Further Studies on the Microscopic Examination of Starch Grains in Relation to Maturity of Lima Beans

In the previous paper *(2)*, it was reported that the microscopic examination of starch grains of lima beans may be adapted for possible commercial application. This paper presents the results of a study made in 1954 to determine the effect of maturity in relation to the size of beans on the average size and shape of the starch grains and the structural development of hylum (hilum) and of lamellae in the starch grains of lima beans.

Experimental methods. Lima beans of varieties—Clark's Bush, Limagreen, and Forkhook 242—were seeded 6 inches apart in 18-inch rows on May 15, 1954, on sandy loam soil at the Farmington Field Station, Farmington, Utah. Cultivation and supplementary surface irrigation were employed as often as needed. The plots were harvested on September 17. Following harvest, the pods were shelled, beans were screened, separated, and were designated as follows:

Tiny—Beans held on a 18/64-inch screen but passed through a 30/64-inch screen.

TABLE 1

The effect of size of beans on the size, shape, and structural development of hylum of starch grains of Clark's Bush, Limagreen, and Fordhook 242 lima beans.

Variety	Size of beans taken	Average size of starch grains (microns)	Shape of starch grains (per cent)			Starch grains (per cent) in developmental classes of hylum					Lamellated starch grains (per cent)
			Circular	Oblong-elliptic	Irregular	1	2	3	4	5	
Clark's Bush	Tiny	84.3	44.4	36.1	19.4	55.6	38.9	5.5	....	....	37.3
	Small	103.4	30.6	69.4	....	11.1	11.1	25.0	27.8	25.0	51.2
	Medium	119.7	27.6	58.4	13.9	5.6	....	13.9	41.6	38.9	59.2
Limagreen	Tiny	95.2	38.9	50.0	11.1	50.0	41.7	8.3	....	....	42.7
	Small	97.9	58.3	38.9	2.8	33.3	16.7	13.9	22.2	13.9	57.4
	Medium	111.5	44.4	52.8	2.8	11.1	5.6	16.7	33.3	33.3	85.1
Fordhook 242	Tiny	76.2	25.0	30.6	44.4	97.2	3.8	....	....	....	10.2
	Small	99.3	33.3	47.2	19.5	58.3	38.9	2.8	....	....	24.9
	Medium	100.6	36.1	58.3	5.6	47.2	30.6	13.9	5.6	2.8	40.2
	Large	107.4	69.4	27.8	2.3	50.0	5.6	25.0	36.1	30.6	79.7

[1] 1 = unhylumed, 5 = highly hylumed.

Small—Beans held on a 30/64-inch screen but passed through a 34/64-inch screen.

Medium—Beans held on a 34/64-inch screen but passed through a 38/64-inch screen.

Large—Beans held on a 38/64-inch screen.

Dry and shrivelled beans were discarded. The beans were then washed and a slurry of beans from each size group (whenever available) was prepared in 95 per cent ethyl alcohol with the aid of a Waring blender. The microscopic study was made on hundreds of starch grains from each slurry. A standard method of microscopic examination of starch grains of lima beans *(2)* was used. This examination of starch grains consisted of:

Size: Maximum length of each of the random starch grains was measured and average size in microns was computed.

Shape: Circular, oblong-elliptic, and irregular shapes of starch grains were recorded and calculated on a percentage basis.

Development of hylum: Arbitrary classes 1, 2, 3, 4, and 5 were given to hylums of starch grains according to their structural development. These classes may be described as follows:

1 = Unhylumed starch grain

2 = A slight slit of hylum

3 = Conspicuous hylum with its ramifications

4 = Conspicuous hylum with thickened ramifications

5 = Profusely ramified and highly thickened hylum.

Percentage distributions of starch grains in the developmental classes of hylum were calculated.

Development of lamellae: The percentage distribution of distinctly lamellated starch grains was studied.

Observations. The data presented in Table 1 indicate that the size of starch grain is directly correlated to the size of bean. That is, the length of starch grain increased as the size of bean increased, regardless of varieties studied. Minimum length of a starch grain recorded was 27.0 microns and the maximum was 204.0 microns.

The largest percentages of starch grains of circular shape was in "tiny" beans of Clark's Bush, in "small" beans of Limagreen, and in "large" beans of Fordhook 242. The starch grains of Fordhook 242 were either oblong, elliptic, elongated, or irregular from the "tiny" and "small" beans and were circular from the "medium" and "large" beans.

Regardless of varieties studied, the hylum of starch grains became prominent and ramified as maturity of beans (in relation to the size) increased. This concurs with the earlier findings *(1, 2)*.

The elongation of the hylum always occurred in the direction of longer axis of a starch grain. However, in a circular starch grain, the hylum developed in all the possible directions in the starch grain. It was noticed that the number of distinctly lamellated starch grains increased as the size of beans increased. It was further noticed that the number of lamellae became considerably conspicuous, when the starch grain was profusely hylumed.

From the observations and results, it is concluded that the starch grain becomes larger in size, more regular in shape, progressively prominent in hylum and in lamellae, and of increased number in lamellae as the physiological maturity of lima beans advances.

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Utah State Agricultural College
Logan, Utah

REFERENCES

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2. Salunkhe, D. K., and L. H. Pollard. A rapid and simple method to determine the maturity and quality of lima beans. *Food Technol.*, **9**, 45-46 (1955).

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Eight leading corporations have joined in a plan to build an atomic reactor for research use. To be called The Industrial Reactor Laboratories, the facility will be located on a 250-acre tract within 50 miles of New York City. Options already have been taken on two sites in New York and New Jersey. Participating in formulation of plans, besides AMF Atomics, Inc., a subsidiary of American Machine and Foundry Co., responsible for the reactor's construction, are Continental Can Company, Chas. Pfizer & Co., Inc., Corning Glass Works, International Nickel Co., Socony Mobil Oil Co., American Tobacco Co., and U. S. Rubber Co. The unit is the first in the world to be owned and operated by private companies for research in the use of nuclear energy in industry and medicine. Cost is estimated between $1,500,000 and $2,000,000. Construction is scheduled to begin in early fall, and the facility is expected to be ready for use a year later. Final site selection is subject to clearance by the Atomic Energy Commission, from which the reactor's fissionable fuel will be obtained on a lease basis. Operation of the Laboratories will be directed by a leading university, according to policy set down by a Board of Directors to be made up of representatives of the participating firms, and ownership will be vested in a corporation in which each company will have equal stock interest.

Two graduate assistance grants totalling $1000 were voted by the Dairy Remembrance Fund at its annual meeting on June 16, it was announced by Mr. Madison H. Lewis, president of the Fund. Purpose is to assist two colleges with their research where funds may not be adequate to meet living costs of research assistants. Applications may be made by college dairy departments to the Allocations Committee, Mr. W. A. Wentworth, chairman, 350 Madison Ave., New York 17, N. Y.

A revolutionary method for shipping frozen foods began its first test at sea recently on a voyage to Guanta, Venezuela. The test involves use of an insulated aluminum container filled with three tons of frozen fruits and vegetables—superchilled with liquid nitrogen to —150° F. The all-aluminum container was supplied by Aluminum Company of America, 1501 Alcoa Bldg., Pittsburgh, Pa. The container requires no refrigeration equipment whatsoever, yet will keep its load of frozen foods below 0° F. until delivered in Guanta. The super-chill method of shipping frozen food is expected to be less expensive than any current system and is reported to be definitely more efficient. The insulated aluminum container was loaded and super-chilled at a Chicago warehouse, then sealed and shipped by truck to New York, where it was placed on the deck of the *Santa Monica*. The test ship is a joint project of Grace Lines, Libby, McNeill & Libby, and Aluminum Company of America.

Three distinguished scientists have been selected to judge entries in the fourth annual Glycerine Research Awards. They are Dr. J. C. Cowan, Northern Utilization Research Branch, USDA; Dr. Robert S. Harris, Massachusetts Institute of Technology; and Dr. E. G. Klarman, Lehn & Fink Products Corp. Nominations for these awards, granted for original research on the chemical, physical, or physiological properties of glycerine or glycerine-derived or glycerine-containing materials, must be submitted to the Awards Committee, Glycerine Producers' Assn., 295 Madison Ave., New York 17, N. Y., by Nov. 1, 1955. Award winners will receive stipends of $1000, $300, and $200 for first, second, and third place respectively at the annual meeting of the Glycerine Producers' Association in New York City next January.

Shown at the Argonne National Laboratory, Lemont, Ill., recently, at the initiation of the Laboratory's radiation of food products (a part of the extensive Quartermaster Corps project), are, from left: Col. John D. Peterman, QMC, commandant of the Quartermaster Food and Container Institute for the Armed Forces, Chicago; Mr. Lester Furney, Argonne director of publicity; Mr. Harry Williams, vice president, Wilson and Co.; Lt. Col. Belmont Evans, Jr.; CmlC, Nuclear Effects Officer with the Radiation Sterilization Project at the Quartermaster Institute; and Dr. Norman Hilberry, assistant director, Argonne National Laboratory. Object of attention is a boned ham which had been subjected to an irradiation dosage of 2,000,000 rep approximately three months earlier.

American diners soon may be flavoring their steaks with catsup that comes from toothpaste-type tubes. This is the prediction of Mr. Nicholas Marchak, director of engineering of the Sun Tube Corp., Hillside, N. J., who surveyed the collapsible tube industry in England, France, Germany, Italy, Switzerland, Sweden, Denmark, and Finland. Many tourists—such as those pictured in "Cinerama Holiday," who are introduced to catsup in a tube in a Swiss ski lodge—are coming back to America and spreading the news of

(Continued on page 32)

PRIZE-WINNING BUTTERMAKERS PREFER DIAMOND CRYSTAL FLAKE BUTTER SALT!

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...rystal Flake Butter Salt for over 10 years," says prize winner Donald Hedding, "because Diamond Crystal's 'soft flakes' consistently do the best job in buttermaking of any salt I've ever seen! I'm sold on the way it dissolves quickly and completely in butter . . . leaves no grittiness. Diamond Crystal Flake Butter Salt never requires extra-long working which can produce mottled, sticky butter. It has a pure salt flavor that never imparts a strong, brackish flavor to butter. I've seen what it can do," says champion Donald Hedding, "and that's why it's my choice!"

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FOOD INDUSTRY TOPICS

(Continued from page 30)

the handy containers, he continues. He reports as another interesting trend in European food packaging the use of the seamless metal shell for beverages. "This eliminates any metallic taste in the liquid, which arises from the seams of cans," he stated. This type of shell is manufactured by impact extrusion, the same process used on collapsible tubes.

◆ ◆ ◆

The average American family uses 38 folding paper cartons every week, according to a survey made by the Folding Paper Box Assn. They use this number of containers to protect food, beverages, tobacco, textiles, cosmetics, hardware, and hundreds of other household goods. Statistics showed that over a year the family uses about 2,000 folding cartons—double pre-war use. Mr. A. E. Murphy, executive secretary, estimated that the increase is due largely to the postwar marketing revolution that has led to greater self-service in retail stores and development of such convenience items as frozen foods, ready-mixed flours, pre-packaged produce, and carry-cartons for beverages.

◆ ◆ ◆

Experiments at the Southern Utilization Research Branch, USDA, 2100 Robert E. Lee Blvd., New Orleans 19, La., indicate that many excellent candies can be made at reduced cost by use of turbinado or ion-exchange sugars in place of the more expensive granulated. In the studies, carried out in cooperation with the National Confectioners' Assn., turbinado sugar was used successfully for caramel, fudge, brittle, and strawberry pectin jelly. White nougat, grained mints, clear hard candies, and pectin and starch jellies, produced experimentally with ion-exchange sugar, compared favorably with similar candies made with regular granulated sugar.

. . . *things new under the sun*

Abbott Laboratories this summer introduced Improved Sucaryl,® a new, non-caloric sweetener which reportedly provides sweetening superior to that of the old Sucaryl and to that of other non-nutritive sweeteners because it eliminates bitter aftertaste for all practical purposes. Distribution is through pharmacies and drug sections of department stores. Homemakers will be able to use the improved sweetener in a much wider variety of cooked, baked, canned, or frozen foods. For persons on salt-free as well as sugar-restricted diets, Abbott is adding a third form of calcium Sucaryl, a tablet. The new calcium tablets will be in bottles of 100 and 1000. A new 44-page Sucaryl recipe booklet is being distributed through pharmacies and from Abbott's headquarters in North Chicago, Ill.

◆ ◆ ◆

Niagara Blower Co., 405 Lexington Ave., New York 17, N. Y., has introduced a new apparatus providing water saving in industrial cooling and giving close control of temperatures (within 2° F.). The new patented machine, named the Panel Casing Aero Heat Exchanger, cools by evaporation and obtains the temperature control by modulating the use of outdoor air. In the process industries, it is used in cooling chemical reactions, evaporating, distilling, condensing. It is

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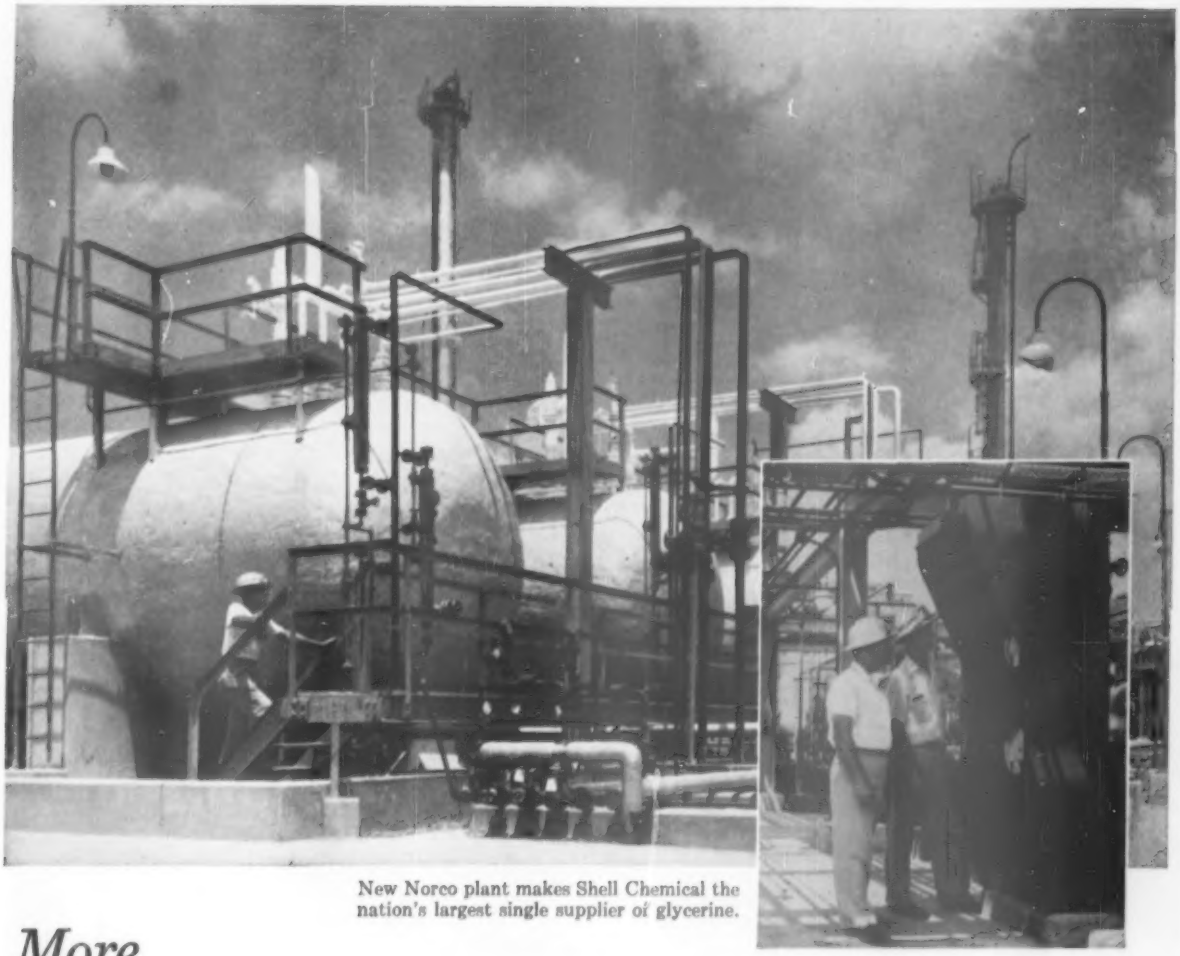

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FOOD INDUSTRY TOPICS

(Continued from page 32)

adapted also to cooling compressed air and gases. The Exchanger may be installed anywhere; the usual location is outdoors, on the ground, or on a roof. In this model, four sizes afford capacities from 7,000,000 to 18,000,000 BTU/hr. under standard conditions. Maximum space required in ground plan is 194″ x 140½″; in height 125⅝″. Weight range is from 9300 to 20,500 lbs., approximately. The manufacturer also builds both smaller and larger units in other types.

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A tinless, organic solder that shows promise of relieving the container industry of its dependence on imported supplies of tin has been announced by Dewey and Almy Chemical Co., division of W. R. Grace & Co., 62 Whittemore Ave., Cambridge 40, Mass. According to Mr. D. L. Shanklin, general manager of Container and Chemical Specialties, "The new bonding agent is a thermo-plastic organic material having excellent adhesion to plain metal as well as to most of the interior lacquer coatings used in cans today. It also has high strength," he reported, "testing an average of 15 pounds stronger than tin-lead solders. Normal food processing temperatures (240° F. for 30 minutes) do not affect the bond." The new high strength solder reportedly is an extension of similar low-strength cements announced by Dewey and Almy several years ago and now being used in billions of motor oil cans. Food processors also have started to use them to seal frozen concentrate packs and tomato paste cans.

◆ ◆ ◆

A new type of pH-sensitive glass which will benefit both laboratory and process control users of pH equipment now is being incorporated into certain pH electrodes manufactured by Beckman Instruments, Inc., Fullerton, Calif. Known as E-2 glass, the new formula is suited especially for high pH measurements. Type E-2 replaces Type E glass in the original Beckman blue-tipped, alkali-resistant electrodes. Electrodes with the new formula glass are extremely valuable in the range above pH 10 where other electrodes fail to perform satisfactorily. Unlike older electrodes, they also are good over the entire 0-14 pH range at temperatures from 15° to 100° C., and offer improved resistance to acids, surface deterioration, aging, and alkalies. E-2 glass electrodes are available for use with Beckman Models G, M, N, H, and H-2 pH meters, and Beckman industrial pH flow and immersion assemblies.

◆ ◆ ◆

Riegel Paper Corp., 260 Madison Ave., New York 16, N. Y., reports that it faces an unusual problem due to development of **an amazing new paper** that is extremely resistant to passage of oil, water, and other liquids, but will permit air to pass through freely.

(Continued on page 36)

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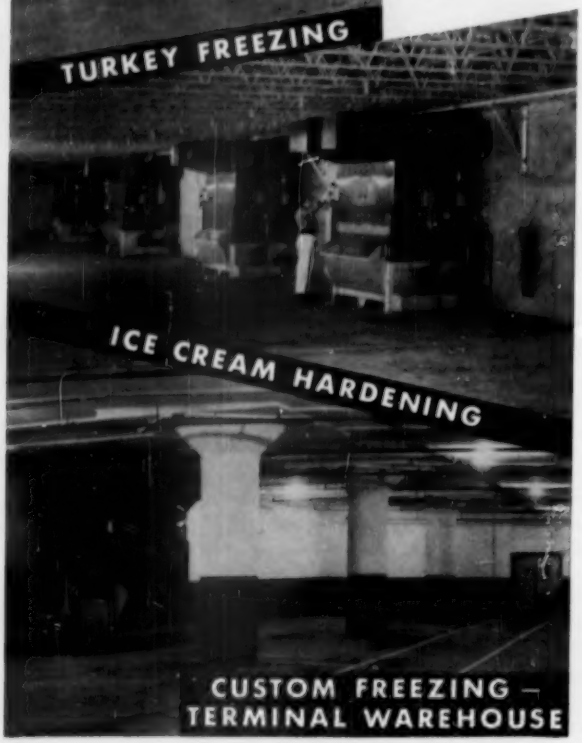

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FOOD INDUSTRY TOPICS

(Continued from page 34)

Having developed it, the question is, "What to do with it?" There may be many uses for this amazing new paper, but Riegel wants to know, "Who needs a paper with these extraordinary properties?"

Riegel also announces the first commercial run of **synthetic paper made wholly from nylon fiber.** The paper is almost impossible to tear by hand, and is many times stronger than paper made with rags or wood pulp. In addition, it is highly resistant to chemical attack, absorbs very little moisture, and resists action of molds, bacteria, and light. It is suggested for use in such applications as heavy-duty bags, filtration of corrosive liquids, packaging chemicals, map and tracing papers, and for important records and documents where permanence is necessary. At present, its cost is considerably higher than paper from rag or wood pulps, although costs are expected to decrease as production increases.

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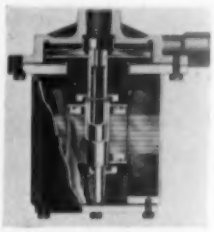
New methods of construction, new materials, and a new cooling circuit are offered in the Model S series seal-less centrifugal pumps recently announced by Chempump Corp., Station H, 1300 E. Mermaid Lane, Philadelphia 18, Pa. Fabricated parts can be clad with such metals as titanium, zirconium, Hastelloy series metals, Monel, Carpenter 20, and the various types of stainless steels previously available, providing corrosion-resistant service on a wide scale. Approximately 400% more bearing area is offered by the patented Graphitar semi-floating bearings developed for the new series. The new 1/3 through 3 hp leak-proof units are priced from $100 to $150 lower than their older but still available counterparts, the Model C series.



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A new Handler tractor for factories, warehouses, and terminals which can haul loads up to 15 tons despite comparative small size has been introduced by The Colson Corp., Elyria, O. The new 6 hp unit features single lever control, no clutch, two forward and two reverse speeds, cushioned "dead man" brakes, and instantaneous reversing without shifting or rotating the power unit. A simple coupling device facilitates hooking to all types of truck and hauling equipment. Because of its 40" turning radius, it is of particular value for use in narrow aisles. Maximum speed of the 1500-pound tractor is 4 mph. List price is $1,395, F.O.B. Elyria.

◆ ◆ ◆

From Jefferson Chemical Co., Inc., 260 Madison Ave., New York 16, N. Y., comes word that its Ethylene Glycol is finding use in dry-type electrolytic condensers and in the production of polyester-diisocyanate polymers, in addition to its older, well-established uses which includue non-volatile automotive antifreeze, functional fluids, alkyd resins, and low-freezing dynamite. The firm's various stock-point lo-

(Continued on page 38)

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FOOD INDUSTRY TOPICS

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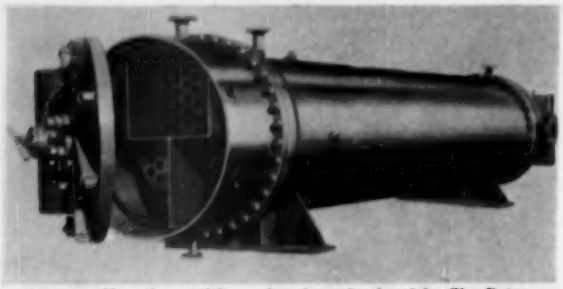

A new, self-seating, quick-opening door, developed by The Paterson-Kelley Co., Inc., 10 Lackawanna Ave., East Stroudsburg, Pa., considerably reduces the time needed to open heat exchangers, autoclaves, sterilizers, and other pressure vessels. Taking about five seconds to open, the p-k Lever-Lock Door (patent pending) is locked and unlocked by means of bars. Standard exchanger doors normally are bolted closed, and require an hour or more to take off and put on. Capable of withstanding temperatures from −70° to 400° F., and pressures ranging from full vacuum to 300 psi, the Lever-Lock has a tight-fitting closing gasket and automatically seats itself when closed. A mechanical lock safety device prevents the door from being opened while the vessel is under pressure.

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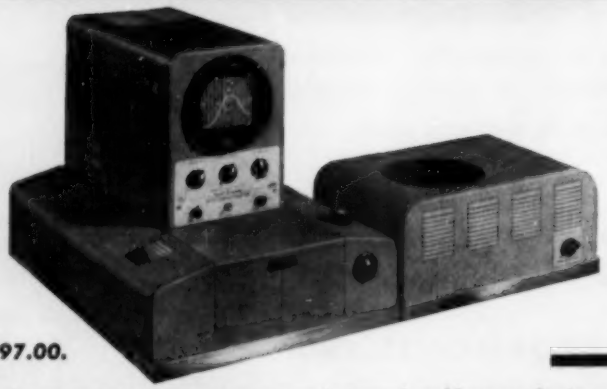
Stainless steel beverage tubing for use as syrup lines, carbonated water, beer, refrigeration, and cooling lines, and in water coolers, carbonators, vending machines, and similar equipment has been announced by Superior Tube Co., 1697 Germantown Ave., Norristown, Pa. The tubing is produced by fusion welding using only carefully selected stainless strip steel, and has no filler metal or flux to impair purity and resistance to corrosion. It is competitively priced with beverage tubing made from other materials. The three standard sizes of mill stocks—shipped in 50′ coils only—are: ¼″, 5/16″, and ⅜″ outer diameter, with .020″ wall for each size. Minimum quantities of mill stocks shipped are 200′ per size. Coils up to 75′, straight lengths, and 7/16″ and ½″ diameter beverage tubing can all be produced to order. Wall thicknesses of .025″, .028″, .032″, and .035″ also are available. Write for Data Memorandum No. 16.

◆ ◆ ◆

Development of a technique which promises to end most scrubbing and scouring chores for housewives was announced by Mr. Frank E. Hammond, president of Selinized Process Co., 1100 S. Saddle Creek Rd., Omaha 6, Nebr. The method "adhesion-proofs" metals and has dramatic applications to cooking utensils, kitchen appliances, and oven interiors by permanently eliminating need for soaking, scrubbing, or scouring to remove sticking food. Greasing is necessary only where it contributes to flavor. The process, called "Selinization," also permanently protects utensils from discoloration, corrosion, and pitting, it is claimed. The firm is negotiating with several major

(Continued on page 40)

NEW LOWER PRICE
REMOTE INDICATING SPECTROPHOTOMETER
PULSING ATTACHMENT



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The AO Rapid Scanning Spectrophotometer traces 60 separate curves per second recording a "moving picture" of color changes taking place in a specimen over the entire visible spectrum (wave lengths from 400 to 700 millimicrons). Allows fast analysis of transparent (up to 100mm thick) or opaque materials; gaseous, liquid or solid. In addition to general investigative work it can be used for following color changes and transient phenomena.

New Remote Indicating Spectrophotometer — The answer to certain control problems on flowing materials such as dyes or petroleum products. Indicator unit can be placed up to 50 feet away from spot where check on process takes place.

New Pulsing Attachment — This new electronic attachment allows a choice of one, six or sixty scans per second. Some slow chemical reactions cause the normal 60 cycle scan to produce partially overlapping or blurred spectrum curves. For studying such reactions, this attachment shows well separated, meaningful curves.

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1-46

FOOD INDUSTRY TOPICS

(Continued from page 38)

appliance and utensil manufacturers, and also will market its own line of cooking utensils. Patent for the process is pending.

◆ ◆ ◆

A complete new line of Swagelok tube fittings made of Du Pont "Zytel" polyamide resin for plastic tubing where corrosion is a problem, is announced by Crawford Fitting Co., 884 E. 104th St., Cleveland 10, O. The fittings are reportedly the first to be made in elbows, tees, reducers, adapters, plugs, caps, and bulkheads. Swagelok tube fittings of "Zytel" are made to the same patented design as Swagelok metal tube fittings. Neither type requires preparation of tubing; the tubing is inserted in the fitting and the nut tightened.

◆ ◆ ◆

Designed to light the interior of metal tanks and kettles, a new Crouse-Hinds Type V observation light condulet permits visual inspection through observation windows of food contents during processing. Its strong, heat-resisting glass globe eliminates breakage and food loss from glass particles. This observation light is vaportight—so made that vapor cannot enter the conduit system even when the globe is removed. For use with 50, 60, 75, or 100 watt lamps. Write Crouse-Hinds Co., Wolf & Seventh North Sts., Syracuse, N. Y.

A multiple-range strip chart recorder, which automatically switches between a series of full-scale ranges of 0-110, 100-210, and on up to 900-1010 millivolts, is being produced by Applied Physics Corp., 362 W. Colorado St., Pasadena, Calif. The Model 39 multiple-range recorder is particularly useful for measuring small voltages or currents with an electro-meter, where e.m.f. values must be recorded with high accuracy over a wide range of values. Range switching is performed by limit switches at the ends of the recorder slidewire so that a higher or lower range automatically is selected when the recorder pen reaches either end of the scale.

◆ ◆ ◆

Development of "Modular" Multi-Vent, a competitively-priced version of the established Multi-Vent air diffusing principle, which provides draftless air conditioning and uniform temperature control for food processors, laboratories, stores, and offices, is announced by Multi-Vent Division of the Pyle-National Co., 1334 N. Kostner Ave., Chicago 51, Ill. The diffuser is stated to be the only one that makes possible draftless air conditioning, particularly where a high number of air changes is required. The advantages of Modular Multi-Vent also apply to heating and ventilating systems. The new unit is a standardized, smaller version of the patented Multi-Vent units used for years in railroad cars, and in hospitals and laboratories. It employs a perforated ceiling panel to introduce air vertically, and at low velocity into a room. The units run in price from $5.75 up. Eight Modular Multi-Vent units would be required in a room measuring 25 by 25 by 12 feet, having an average heat load.

◆ ◆ ◆

A new fraction collector for chromatography is being offered by Schaar and Co., 754 W. Lexington St., Chicago 7, Ill. Collections can be made automatically by either the "timed flow" or the "volumetric" method. Both culture and lipped tubes may be used for collection since support is furnished at bottom of tubes. Three interchangeable receiver tables or a large adapter unit for large volumes are available. All tables are equipped with three mounting holes for indexer, and are interchangeable with one indexer. An electronic timer-controller, capable of indexing each tube to receive fractions on a timed-flow basis from 18 seconds up to two hours, is supplied if desired. Supplementary parts, including a wide range of siphon assemblies, make this equipment extremely versatile.

◆ ◆ ◆

Silicone-treated glassware is now on the market. First to enter commercial production is the Brockway Glass Co., who, in cooperation with Dow Corning Corp., Midland, Mich., have shown that there is no contamination of food when Dow Corning EF-4010 is used to coat wide mouth food containers both inside and outside. Among advantages claimed for silicone-treated glassware are: (1) a greatly increased apparent strength due to the protection of the glass surface from abrasions received through normal handling (Actually, the strength of the glass is not increased;

(Continued on page 42)

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Seaplant CHEMICAL CORPORATION
63 David Street, New Bedford, Mass.

FOOD INDUSTRY TOPICS

(Continued from page 40)

rather, the original high intrinsic strength of a pristine container is preserved); (2) decrease of breakage due to impact as the lubricating film provided by the silicone converts impacts directed at an angle less than 90° into harmless, glancing blows; (3) better vacuum or pressure retention with easier cap removal; (4) spectacular drain-back and pour-out properties for aqueous products; (5) smoother and quieter line operation with less jamming as the bottles are self-lubricating; (6) more complete drain-out of rinse water; and (7) possibilities of greater savings through glass light-weighting and/or carton redesign.

◆ ◆ ◆

Developed especially for the food field, where sanitation is of paramount importance, the new Mercury Sanitized Pulley is a strong steel pulley completely enclosed in a molded cover of a specially formulated plastic. The plastic coating is 5/16" thick, and is securely bonded to the pulley by a newly discovered molding technique. There is no exposed metal, other than the S.S. shaft, with no cracks or crevices to permit contamination or bacteria build-up. The unit cannot corrode, and is highly resistant to acids, oils, alkalis, and greases. Manufactured by Mercury Conveyor, Inc., Hillsdale, Bergen County, N. J.

◆ ◆ ◆

A 3/4" all-brass valve, only 3" across and about 2" deep, the SOLOMITE Multiport Lift-Turn Valve is a miniature version of the familiar SOLO Valve, manufactured by AquaMatic, Inc., Rockford, Ill. The valve changes the 4-way or 3-way circuits by lifting the handle and turning it to drop into the proper slot. The valve is applicable to piping systems requiring 2- or 3-position control or 3- and 4-way circuits. Address inquiries to the firm c/o Cummings, Brand & McPherson, 2929 N. Main Rd., Rockford, Ill.

◆ ◆ ◆

Experiments conducted at the American University of Beirut, Lebanon, by Prof. Toufik Zakharia have resulted in a **new method for separation of endosperm, bran, and germ of wheat.** The professor reportedly has been able to retain 54% protein value and reduce the carbohydrates to an average of 30% in his new flour. Bread produced using the flour has a texture resembling regular white bread, and a color slightly lighter than American style rye bread. Dietary tests indicate the flour is highly valuable in dietary treatment of cases of chronic digestive disturbance, diabetes, and anemia. Prof. Zakharia has leased his process patents to International Hygienic Food Co., P. O. Box 3258, Beirut, Lebanon. The firm plans to make the process available to food grain processors in other countries at minimum cost. Manager of the company is Mr. Munir Salim Haddad.

◆ ◆ ◆

From Podbielniak, Inc., 341 E. Ohio St., Chicago 11, Ill., comes word that its line of Contactors, tailored for maximum efficiency, are effecting unprecedented economies in such installations as food processing, degumming of soybean oil, removal of acetic acid from waste sulphite liquors, extraction of aromatic hydrocarbons, and dephenolizing of ammoniacal liquors. The firm recommends that its units be given special consideration wherever processing by solvent extraction, counter-current contacting, washing, or sterilizing are an essential part of product processing. Mrs. W. J. Podbielniak is executive vice president.

◆ ◆ ◆

Any table model circular saw can be made completely safe with a **new gliding-action 1/4" clear plexiglas guard** which lets the user see all work operations through transparent shields. The Safety Glide Guard protects during cut off, ripping, dado, and grooving work to various widths and thicknesses. It is never necessary to remove the guard. For extra safety, the unit is equipped with the largest and strongest dual "anti-kick backs" reportedly ever used on a saw guard. Among new design features is an adjustable splitter which conveniently adjusts to clear work when not in use. Two models are available—one for commercial use, and a lower-priced unit for 6" and 8" home workshop saws. Write General Scientific Equipment Co., 2700 W. Huntingdon St., Philadelphia 32, Pa.

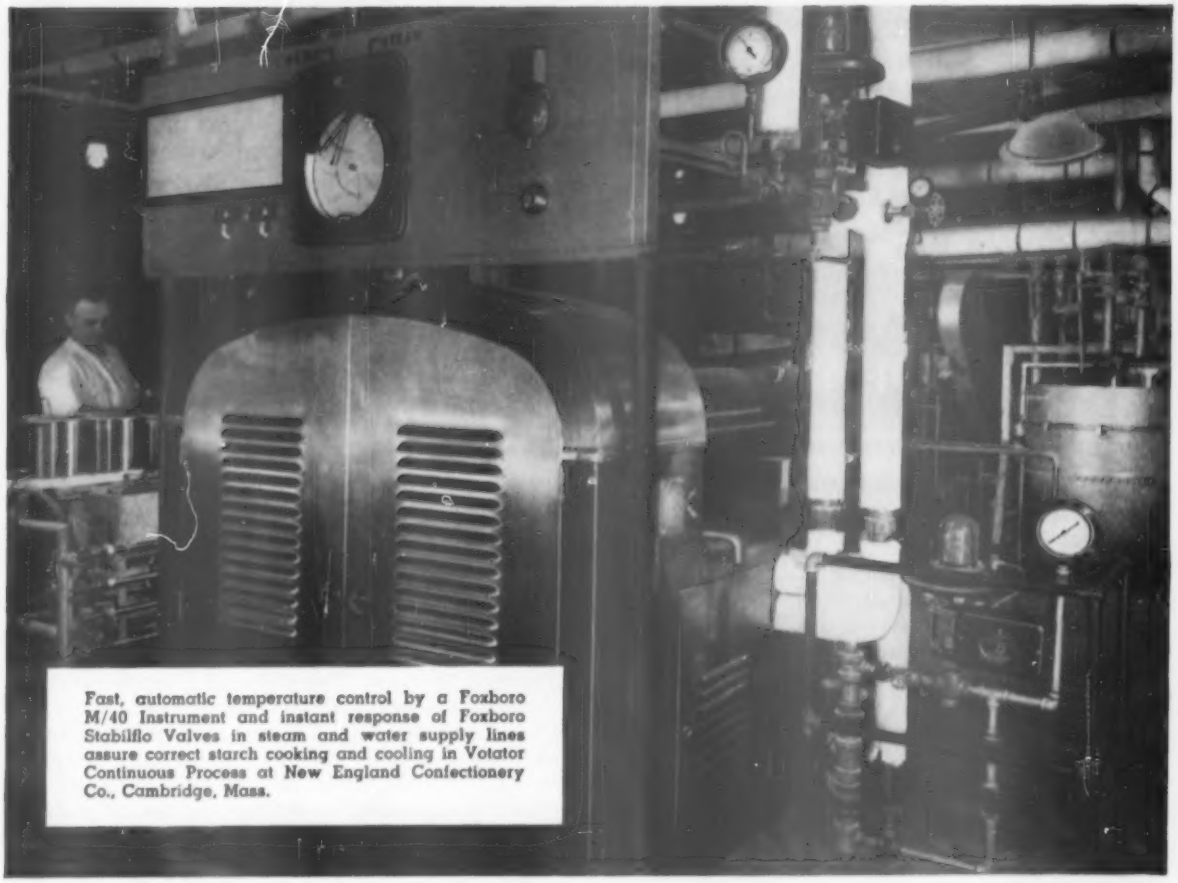
◆ ◆ ◆

The Film Division of Olin Mathieson Chemical Corp., 655 Madison Ave., New York, N. Y., is offering its Tra-Pak free of charge to the trade. The Tra-Pak, which has inspired packaging decisions since introduced 18 months ago, consists of eight sample trays, each representing a basic packaging idea. It helps executives develop quickly the type of tray design that

(Continued on page 44)

Necco* CUTS COOKING TIME FROM ¾ hr. to 2 min.!

...with Foxboro-controlled Continuous Process



Fast, automatic temperature control by a Foxboro M/40 Instrument and instant response of Foxboro Stabilflo Valves in steam and water supply lines assure correct starch cooking and cooling in Votator Continuous Process at New England Confectionery Co., Cambridge, Mass.

Precise Foxboro Control on equipment permitting a higher cooking temperature has enabled the New England Confectionery Company to switch from batch to continuous processing of starch jellies . . . with a 95% saving in cooking time.

This rapid process, which also greatly improves gel strength, shelf life, and clarity, is carried out in a Votator Heat Exchanger†. A sensitive, fast-acting Foxboro M/40 Controller maintains pre-set cooking and cooling temperatures by automatically adjusting valves in the steam and water supply lines. Regardless of changes in steam, starch, or water flow, the M/40 Controller holds critical temperatures *exactly* . . . protects the uniformity and quality of up to 4000 lbs. of starch jelly per hour.

Many other food processors now depend on Foxboro Control Systems to maintain premium product quality at lowest operating cost. Write for information on better control for *your* process.

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†Manufactured by The Girdler Company, Louisville, Ky.

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FOOD INDUSTRY TOPICS

(Continued form page 42)

best fits today's self-service packaging requirements for food, candy, drug, and other consumer needs, according to the company. The item can be obtained from the company, address above, or from any Olin Cellophane converter.

◆ ◆ ◆

A powerful new electrically powered insect-killing weapon that fires one billion insecticide "bullets" per second in the form of a penetrating fog is offered by Silver Creek Precision Corp. Weighing only 9 pounds and equipped with a detachable stand, the portable Microsol fog generator has a built-in fan which rotates at 19,000 rpm. It converts any insecticide into micron-size particles capable of covering 64,000 square feet in 15 minutes. For further information write Daniel J. Edelman & Associates, 409 Merchandise Mart, Chicago 54, Ill.

◆ ◆ ◆

The housewife's dirtiest and most dreaded task, oven cleaning, is made easy, economical, speedy, and safe by a revolutionary new push-botton aid, "Hep Safe-T-Spray Oven Cleaner," introduced by Bostwick Laboratories, Bridgeport 5, Conn. The product removes burnt-on food and grease in 10 to 15 minutes, simply by fingertip spray application followed by effortless wiping off with damp dishcloth. No brush is necessary. The new product is non-flammable. "Hep Oven Cleaner," backed by a money-back guarantee, is available in regular size, retailing at 98c, and large economy size at $1.49.

◆ ◆ ◆

More natural flavors in canned foods, fruit drinks, and beverages are assured through development of a **new heat-resistant liner for metal containers**. Made of resinous plastic-like material, the liner permits use of aseptic canning for products such as dairy foods, soups, and vegetables. A product of the can division of Crown Cork & Seal Co., the liner has excellent chemical resistance and superior adhesion and fabrication properties. In addition to pre-sterilization of the food and can filling in an aseptic manner, the process requires pre-sterilization of the container at 500° F. The process reportedly is so rapid that the flavor, color, and texture of the food or beverage remain virtually unaltered from the original. For information write Arthur L. Greene, 152 W. 42nd St., New York 36, N. Y.

◆ ◆ ◆

In addition to halting jamming of materials being moved from bins, the AiroViber Vibrator, product of Viber Co., 726 S. Flower St., Burbank, Calif., can be used to good advantage in loading, unloading, moving, packaging, processing, or grading. Simple design of the unit provides only one moving part, a heavy steel ball running on a circular track. With no loose-fitting parts to lubricate or adjust, the AiroViber is foolproof in operation. Because of its construction, it will start and operate in any position. It performs at high or low temperatures, and is not affected by humidity, contaminated atmosphere, or contaminated air supply.

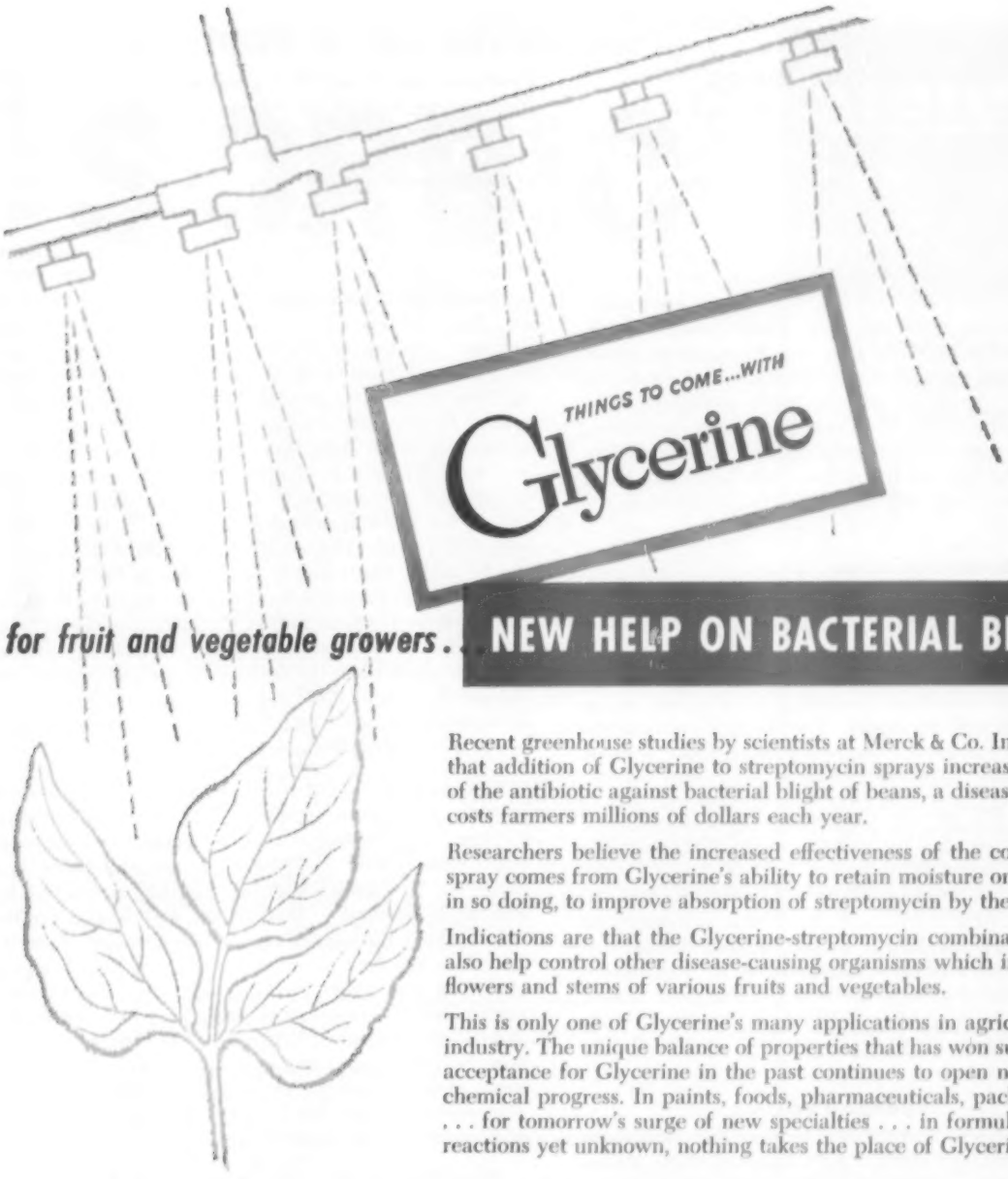
◆ ◆ ◆

Automation has been brought to the baking industry with introduction of "Liquimatic" Automatic Metering Systems. Patented and manufactured exclusively by Liquimatic Systems of Los Angeles, the system automatically dispenses metered shortening, and has been used also to feed exactly controlled amounts of sugar, syrup, oil, etc., into the mixers. Designed and installed to overcome the specific problems of mass production in the baking industry, over 200 installations of various sizes reportedly have proven that the "Liquimatic" Automatic Bulk Metering System has completely amortized its initial cost in as short a time as one year, through savings in labor, time, and the advantages of tremendous bulk purchases. Write Enyart & Rose, 940 N. Fairfax Ave., Hollywood 46, Calif.

◆ ◆ ◆

Development of a new adsorption type, heavy duty dehumidifier, suitable for use in factories, warehouses, storage vaults, and other large areas where controlled humidity is desired, was announced recently by Dryomatic Corporation, Alexandria, Va. The Dryomatic T-150 is an automatically regulated dual-tower unit, using silica gel as the drying agent. The machine, self-adjusting to atmospheric conditions, has a dry air output of 150 cubic feet per minute, and is capable of removing four to five pounds of water per hour. Regeneration of the silica gel is accomplished automatically by electric heating elements. The unit measures 51″ x 28″ x 44″, and weighs approximately 400 lbs.

(Continued on page 46)



for fruit and vegetable growers.. NEW HELP ON BACTERIAL BLIGHT

Recent greenhouse studies by scientists at Merck & Co. Inc., show that addition of Glycerine to streptomycin sprays increases the effect of the antibiotic against bacterial blight of beans, a disease which costs farmers millions of dollars each year.

Researchers believe the increased effectiveness of the combined spray comes from Glycerine's ability to retain moisture on leaves, and in so doing, to improve absorption of streptomycin by the plant.

Indications are that the Glycerine-streptomycin combination will also help control other disease-causing organisms which infect leaves, flowers and stems of various fruits and vegetables.

This is only one of Glycerine's many applications in agriculture and industry. The unique balance of properties that has won such wide acceptance for Glycerine in the past continues to open new doors to chemical progress. In paints, foods, pharmaceuticals, packaging . . . for tomorrow's surge of new specialties . . . in formulations and reactions yet unknown, nothing takes the place of Glycerine.

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FOOD INDUSTRY TOPICS

(Continued from page 44)

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◆ ◆ ◆

The Blaw-Knox Rotocel, a continuous extractor for granular solids, was developed originally for extracting oil from soybeans, but has been found adaptable for any material which can form a bed through which solvent can percolate by gravity. By making minor adjustments in the spacing of drainage compartments on the unit, operation can be made essentially full countercurrent, stage-wise countercurrent, or intermediate between these extremes. For further information on the Rotocel Extractor, write Ketchum, MacLeod & Grove, Inc., 411 Seventh Ave., Pittsburgh 19, Pa.

. . . *the literary corner*

A new Eastman Kodak Data Book dealing with two general problems in industrial photography—starting a photographic service department, and operating one efficiently after its establishment—now is available from Kodak Industrial Dealers, for inclusion in its Industrial Data Book series. The 60-page publication, "How to Organize and Operate Photographic Service Departments," is priced at 50c.

◆ ◆ ◆

Volume III of the Annotated Bibliography of Vitamin E, containing references to 996 scientific communications written during 1952-54, now is being distributed by National Vitamin Foundation, Inc., 15 E. 58th St., New York 22, N. Y. Previous volumes by the same authors, Philip L. Harris and Wilma Kujawski of the Research Laboratories of Distillation Products Industries, a division of Eastman Kodak Co., covered the periods 1940-50, and 1950-51. Dr. Norris Embree, director of research at Distillation Products, points out in a preface that abstracts accompanying most of the references are more from the point of view of the physiologist than from that of the chemist or clinician. Wherever possible, the location of the laboratory in which the research work was done is indicated. The volume is available at $3.00 per copy.

◆ ◆ ◆

"Food Additives Stew Still Simmering," headlines *What's New in Food and Drug Research*, July, 1955, published by Food Research Laboratories, 48-14 33rd St., Long Island City 1, N. Y. To quote from the article: "Continued efforts are being made to reconcile the conflicting views of various food and chemical industry groups on the issue of new legislation governing food additives. . . . There appears to be agreement on all sides that prior testing for safety of new additives will be required. Opinion is divided as to whether the toxicological evidence shall be submitted for prior approval ("licensing") by the Secretary of Health, Education, and Welfare, or whether the Secretary shall simply be notified of the intention to market the additive for food use, such notification being subject to restraint by a court injunction. The issue boils down to a question of whether the manufacturer shall bear the burden of proving safety to the satisfaction of the Food and Drug Administration, or whether the latter agency shall carry the burden of proving the opposite to a lay court."

◆ ◆ ◆

The complete line of Fischer & Porter filled thermal systems for indicating, recording, controlling, transmitting, compensating, and programming temperatures from −400° to +1000° F. are illustrated and described in 24-page Catalog 12-A-10, published by Fischer & Porter Co., Hatboro 35, Pa. Shown for the first time are the vapor pressure filled systems recently added by the firm to expand its line of liquid expansion and gas pressure filled systems. Instruments shown include temperature recorders, indicators, dial indicators, recording controllers, indicating controllers, indicating and non-indicating transmitters, program recording controllers, psychrometric instruments (to record wet and dry bulb temperatures), and portable temperature instruments.

◆ ◆ ◆

According to the July *Fatty Acid News Digest*, published by Fatty Acid Division, Assn. of American Soap & Glycerine Producers, Inc., 295 Madison Ave., New York 17, N. Y., the fifteenth revision of the U. S. Pharmacopeia (USP XV) is available and will become official as of December 15, 1955. Printed and distributed by Mack Publishing Co., Easton, Pa., its price is $10.00.

◆ ◆ ◆

In its principal article, "The Story of Oleomargarine," the August issue of *D&O News*, published by Dodge & Olcott, Inc., 180 Varick St., New York 14, N. Y., presents this interesting paragraph: "Recently the U. S. Department of Agriculture has been carrying on considerable research in attempts to create an appetizing spread for bread which can be used in all quarters of the globe. Called 'global edible spread,' or, more simply, just 'global,' the product is made by mixing winterized cottonseed oil with 18% molecu-

(Continued on page 48)

CORRECTION!

In the columns devoted to "Masters and Doctors in Food Technology—1955," July issue of FOOD TECHNOLOGY, p. 14, a misplaced caption resulted in an error that is corrected below. Beginning with the name of Daniel Rosenfield, erroneously listed under Oregon State College, the list should read:

RUTGERS UNIVERSITY AT NEW BRUNSWICK, NEW JERSEY

Rosenfield, Daniel	M.S.	A Study of the Effect of Sodium Chloride on the Electrical Resistance and Capacitance of Lean Ground Pork

STATE COLLEGE OF WASHINGTON AT PULLMAN

Chakravarti, D.	Ph.D.	The Protein Stability and the Wettability of Milk Powder as Affected by Changes in Milk Composition
Donald, Elizabeth Ann	M.S.	Biomicroscopic Observation as a Method of Studying Nutritional Status
Kruiswyk, R.	M.S.	A Study of Methods for Cleaning and Pasteurizing Shell Eggs
Litman, I. I.	Ph.D.	A Study of Fat-Protein Complex in Powdered Milk
Nagnoush, M. R.	Ph.D.	The Oxidation-Reduction Potential as it Applies to Mold Growth

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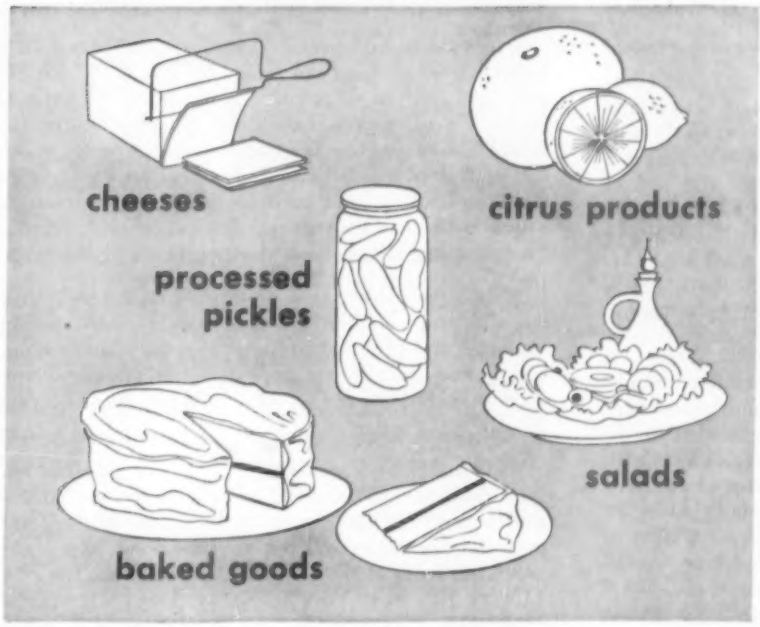
*a **NEW** selective food fungistat for . . .*



- Sorbic can be used with confidence at required levels—it is metabolized like fatty acids in foods.
- Sorbic controls growth of many undesirable microorganisms in foods.
- Sorbic can be so used that it permits the growth of many of the desirable organisms.
- Sorbic contributes no flavor at required concentrations in foods so far tested.

For further information write the CARBIDE office nearest you for technical bulletin F-6568. In Canada: Carbide Chemicals Company, Division of Union Carbide Canada Limited, Montreal and Toronto.

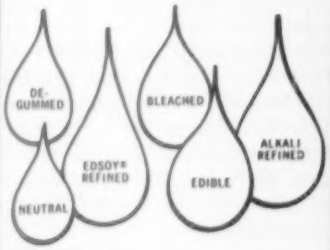
* CARBIDE's *refined sorbic acid for use in foods.*

CARBIDE and CARBON CHEMICALS COMPANY
A Division of
Union Carbide and Carbon Corporation
30 East 42nd Street UCC **New York 17, N. Y.**

Staley's®

Products from Corn and Soybeans

...from Paint to Margarine to Soft Soap



SOY OILS

Versatile soybean oil, the nation's leading domestic vegetable oil, has proved its value to food processors and industrial users all over the country. Bakers and margarine makers, canners . . . paint, ink and linoleum manufacturers, insecticide and soft soap makers, tanners, and pharmaceutical houses, to name a few, all have found advantages in quality of Staley's Soy Oils.

Staley's, the pioneer of the soybean industry, uses solvent extraction methods . . . yielding oils that are *almost colorless.* Of the 6 different kinds of Staley's Soy Oil available, there is one suited to your specifications. A Staley Soy Division representative will be glad to furnish, on your request, complete information on Staley quality Soy Oils, and to recommend the one best suited to your needs.

For information about other quality Staley Industrial products, Soy Flours, Starches, Lecithin, Corn Syrup, Corn Steep Liquor, Amino Acids, etc., write

A. E. STALEY MFG. CO.
DECATUR, ILLINOIS

FOOD INDUSTRY TOPICS

(Continued from page 46)

larly distilled monoglyceride prepared from hydrogenated lard. To this mixture is added salt, coloring, flavoring, and antioxidants. Warming before serving improves the consistency and mouth 'feel,' reports state, but too much warming at too high a temperature makes global too hard. And the higher the temperature, the faster the hardening takes place. 'Global edible spread,' the result of formulations which can be satisfactorily stored and used from the Arctic to the tropics, needs a stabilizer to keep it from getting too hard when stored at 112° F."

◆ ◆ ◆

A new, 4-page folder describing the simplified operation and ease of installation of its new Stationary Centrifugal Tachometers has been released by Boulin Instrument Corp., 65 Madison Ave., New York City. The folder explains and illustrates how the design components of the tachometer are easily adaptable for quick installation on any type of plant operating equipment such as motors, conveyors, machines, turbines, shafting, and specialized equipment—to check and show proper speeds for maintaining optimum performance.

◆ ◆ ◆

"With the coming of the fall season, hard candy flavorings are expected to be in greater demand," states *Ritter Market Report*, August, published by F. Ritter & Co., P. O. Box 39696, Los Angeles 39, Calif. The firm recommends and offers samples of its hard candy Aromessents 12-36, made especially to resist high temperature and priced at $12.00 per gallon or $2.00 per pint. In the firm's True Fruit line, it continues to recommend True Fruit Wonex No. 380-2X Flavors. These include Grenadine, Cranberry, Blackberry, Black Raspberry, Black Cherry, Concord Grape, Pineapple, and Strawberry. Samples of this line, representing double-strength pure flavors enhanced with natural extractives and priced at $10.50 per gallon, also are available upon request. True Fruit genuine flavors are offered at the same price.

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"Report on Radiation of Foods," published recently by The Refrigeration Research Foundation, 200 Midland Bldg., Colorado Springs, Colo., reportedly has received favorable comment from many sources. Copies are available.

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Bulletin No. 755, describing "aiROYmetric" Pressure Generators, designed to produce hydrostatic pressures as much as 500 times greater than normal plant air supplies, is available from Milton Roy Co., Station J, 1300 E. Mermaid Lane, Philadelphia 18, Pa. Information includes over-all capacity pressure ranges, theory of operation and application details in high pressure synthesis, metal fabrication, hydrostatic testing, and high pressure bottle filling.

◆ ◆ ◆

Included in new 24-page Pfanstiehl Specification and Price Catalog are rare sugars, sugar derivatives, amino acids, and other biological chemicals, most of which are available in bulk as well as laboratory quantities. The new schedule reflects lower bulk prices on some items formerly available only in limited quantities. Items of particular interest covered by the catalog include levulose, galactose, bilirubin, salicin, calcium, and sodium glucoheptonate. Write Pfanstiehl Laboratories, Inc., 104 Lake View, Waukegan, Ill.

◆ ◆ ◆

A new 52-page catalog of its complete line of high vacuum pumps, featuring an engineering section containing formulae and data of practical value to all vacuum engineers, is available from Kinney Mfg. Division, The New York Air Brake Co., 3640 Washington St., Boston 30, Mass. Catalog 425 is actually a comprehensive vacuum engineering reference book.

◆ ◆ ◆

A new catalog on Series 60 medium and heavy duty roller conveyors has been issued by The E. W. Buschman Co., Clifton & Spring Grove Aves., Cincinnati 32, O. Twenty pages of data and specifications on the complete line describe the various types, giving capacities of rollers and bearings. Installation views cover many industries, and include roller conveyors combined with overhead cable, live-roller and vertical reciprocating lift, belt, and other types of conveyor.

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A data sheet describing new model Lanco polyethylene sink trap, including design changes, construction, chemical and physical properties of polyethylene material, and installation procedure, is available from Arthur S. LaPine & Co., 6001 S. Knox Ave., Chicago 29, Ill.

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Authentic specimens of 25 different starches and food condiments, mounted on microscope slides, now available to the food industry in a new Allen Reference Set for Microscopists, are described in a leaflet available from R. P. Cargille Laboratories, Inc., 117 Liberty St., New York 6, N. Y. The set comprises specimens of interest for use as standards in microscopical examination of food products, and in quality control and research work.

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"Food Surveys," ranging in price from $13.50 to $16.50, and designed to keep industry posted on newest methods and techniques in production, are available from J. J. Berliner & Staff, 684 Broadway, New York 12, N. Y. A number of Surveys are available in each of the following fields: Alcoholic Beverages, Animal Food, Beer, Cereals and Cereal Products, Condiments, Color-Flavor-Preservatives, Confectionery, Dairy Products, Fruit Products, Meat, Oils and Fats, Marine Products, Packing-Storing-Shipping, Plant

IDEAS FOR IFT EMBLEM WANTED

The Executive Committee of the Institute of Food Technologists has been given the task of selecting a design for an Institute emblem or insignia. President Clifcorn requests all members who so desire to submit suggestions. It should be borne in mind that the design should in some way depict or symbolize the principal objectives of our Society; namely, "The application of science and engineering to the production, processing, packaging, distribution, preparation and utilization of foods."

Pencil sketches are acceptable. Designs should be submitted to the Executive Secretary, 176 West Adams Street, Chicago 3, Illinois, before November 22, 1955.

and Operation, Non-Alcoholic Beverages, Specialty Foods, Sugars, and Vegetable Products.

. . . ***building up and branching out***

An intensified educational program to instruct "the homemakers of today and tomorrow" on the purchase, use, and care of canned foods has been inaugurated by American Can Company. "The double-barreled program is aimed at teen-agers in school as well as the 43 million homemakers now buying canned foods for their families," according to Miss Harriet Jean Anderson, Canco's home economics director. Through this home economics service, Canco is offering a variety of school and household aids, including seven food and beverage recipe booklets, four Canco movie films, meal lesson plans, charts, handbooks and newspapers, magazines, radio and television food news services. Additional information may be obtained from Home Economics Dept., American Can Co., 100 Park Ave., New York City.

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Atlas Powder Company's earnings in first half 1955 rose 33%, with an increase of 4% in sales. Net earnings after taxes in the first six months were $1,644,440, compared with $1,230,656, earned in the same period of 1954. Sales and operating revenues in the first six months of 1955 were $30,007,247, against $28,841,111 for the 1954 period. In March 1955, the firm sold its industrial finishes business, and in April disposed of its laundry roll cover operation. In May, it bought the business of Parke Thompson Associates, designers of fuses and boosters for ordnance materiel.

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The contract for preparing, supervising the administration, and scoring of the Selective Service College Qualification Test for this coming year has been awarded to Science Research Associates, 57 W. Grand Ave., Chicago 10, Ill. The test is one of the bases on which local boards determine which college students should be deferred to continue their educations. The firm, awarded the contract for the second consecutive year, is a leading publisher of tests and psychological instruments. Its tests and guidance materials are being used by more than 21,000 schools and colleges and 5,000 business firms.

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Consolidated Foods Corp., Chicago, has completed negotiations to acquire American Frigid Dough, Inc., Chicago, processor of a quality line of frozen bakery products and prepared frozen foods. According to Mr. S. M. Kennedy, Consolidated Foods president, a new, modern plant will be ready for occupancy shortly as the new home of American Frigid Dough, which will be operated as a subsidiary of Consolidated Foods. Mr. Marvin R. Polkow and Mr. Earl G. McAbery, Jr., AFD president and secretary-treasurer respectively, will continue in their present positions.

◆ ◆ ◆

Rodney Hunt Machine Co., Orange, Mass., announces opening of a new office in the Grand Central District of New York City, providing engineering and sales service for the chemical and food process industries of the Middle Atlantic states and Southern Connecticut. Mr. Warren E. Hesler will be in charge of the office and available for consultation on Turba-Film Evaporators, Rodney Hunt-Luwa Spray Dryers, and other Rodney Hunt process equipment. Address is Rm. 2807, Graybar Bldg., 420 Lexington Ave., New York 17, N. Y.

◆ ◆ ◆

Mr. Perry T. Zenlea, formerly of Eastern Packaging Equipment Corp., announces formation of Canning Machinery Co., P. O. Box 247, Flushing, N. Y. Services of the firm include plant layout work, consultation, and sales and service of packaging and canning machinery. The new firm represents exclusively The Filler Machine Co., Philmont Club Station, Pa., and also represents Canning Machinery Co., Portland, Ore., and Ace Specialty Mfg. Co., Rosemead, Calif.

. . . ***meeting hall and conference room***

"How much money should a company spend, and what ways should it be used, to provide protection against atomic attack?" These and related questions will be discussed November 17 at a conference on "The A-Bomb and Industry—a Prescription for Survival," sponsored by Armour Research Foundation of Illinois Institute of Technology, Technology Center, 35 W. 33rd St., Chicago 16, Ill. Several hundred Midwest industrialists are expected to attend the conference, to be held on the Illinois Tech campus. Speakers will include authorities representing industry, government, and educational and research institutions.

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The time schedule for the 1956 Convention and Exposition of the National Confectioners' Association, to be held June 10-14, 1956, at the Hotel Statler and Mechanics Hall, Boston, Mass., is tentatively patterned after those of previous conventions, according to General Convention Chairman Robert H. Welch, Jr., James O. Welch Co., Cambridge, Mass. Following the Sunday "Get-Together" on June 10, there will be the joint technical meeting of the NCA and AACT, Golf Tournament, and opening of 39th Confectionery Industries Exposition on June 11. June 12 through 14 will feature business sessions, with the closing of the Exposition and closing convention event, the Dinner Dance, on June 14. An interesting ladies program will be provided. Program chairman is Mr. Richard D. Muzzy, Daggett Chocolate Co. Headquarters of the National Confectioners' Association is at 221 N. LaSalle St., Chicago 1, Ill.

◆ ◆ ◆

The first International Conference on the Use of Antibiotics in Agriculture, both animal and plant, will be held in Washington, D. C., October 19-21, 1955. Sponsor is the National Academy of Sciences-National Research Council, 2101 Constitution Ave., N.W., Washington 25, D. C., with the cooperation of the Agricultural Research Institute and supported by the American Cyanamid Co., Merck & Co., Chas. Pfizer & Co., Inc., and E. R. Squibb & Sons. Invitations to participate in the conference have been extended to 24 leading research scientists in Europe, South Africa, Australia, Latin America, and the U. S. Dr. Howard I. Cole, conference secretary, is in charge of arrangements, and Dr. Ted Byerly of the Agricultural Re-

search Center at Beltsville, Md., is chairman of the NAS-NRC Committee which is planning the program for the meeting.

◆ ◆ ◆

The fall meeting of the American Oil Chemists' Society will be held October 10-12 at the Bellevue-Stratford Hotel, Philadelphia. A student session will be one feature of the meeting, which will have three days of concurrent technical sessions. P. E. Ronzone of C. F. Simonin's Sons, Inc., is chairman, and W. C. Ault of Eastern Regional Research Laboratory, USDA, is program chairman.

. . . ***the human element***

Mr. C. J. Steinicke (second from left), supervising brewmaster of the Duquesne Brewing Co., and newly installed president of the Pittsburgh section of IFT, and Dr. I. J. Hutchings (second from right), H. J. Heinz Co., 1957 national convention chairman, extend reciprocal congratulations. Looking on are (left to right): Mr. A. J. Claxton, president, Meadow Gold Dairies, Inc.; Mr. Arthur W. Johnson, Stoner-Mudge, Inc.; Mr. J. L. Secrist, H. J. Heinz Co.; and Dr. C. R. Strumbo, H. J. Heinz Co.

◆ ◆ ◆

Three promotions in the Technical Service Department at Chas. Pfizer & Co., Inc., 630 Flushing Ave., Brooklyn 6, N. Y., were announced by Dr. C. L. Wrenshall, associate director and a member of IFT. **Mr. Richard A. Benedict** was appointed manager of the Industrial Antibiotics Section, **Dr. Robert C. Ottke,** an IFT member, manager of the Development Section, and **Mr. John K. Shaw,** manager, Industrial Section.

◆ ◆ ◆

Dr. R. E. Greenfield, vice president in charge of manufacturing at the A. E. Staley Mfg. Co., Decatur, Ill., has been named to a prominent study position with the U. S. Public Health Service. He will represent the Corn Industries Research Foundation on the National Technical Tank Committee on Industrial Wastes of the Public Health Service. Primary function of the task committee is to coordinate and stimulate development of technique for controlling industrial wastes so as to preserve the quality and utility of the nation's resources.

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Mr. R. E. Rogers, formerly manager of the Los Angeles branch of The Foxboro Co., Foxboro, Mass., has been appointed manager of the instrument company's West Coast sales activities. Replacing Mr. Rogers in his former position is **Mr. E. W. Pitt,** transferred from the Shreveport, La., office. **Mr. D. P. Thomas,** industrial engineer, has been promoted to branch manager at Shreveport. The changes are coincident with establishment of 10 new sales regions, organized for maximum service to industrial instrument users.

Mr. Kenneth G. Voorhees and **Mr. Ivon H. Budd,** president and 1st vice president respectively, of Ungerer & Co., Inc., 161 Avenue of the Americas, New York 13, N. Y., returned early this month after a month's stay in Europe. While abroad, they inspected the facilities of the Ungerer-Vidal Charvet Paris office, and contacted several of the firm's European sources and customers.

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Burnett of Johns-Manville Celite

Appointment of **Mr. Clinton B. Burnett** as general manager of the Johns-Manville Celite Division, was announced by Mr. A. R. Fisher, president of Johns-Manville Corp., 22 E. 40th St., New York City. Mr. Burnett succeeds **Mr. Arthur S. Elsenbast,** a pioneer in development of methods of manufacturing and using diatomite products who retired on July 31. Mr. Burnett, who continues as vice president of Johns-Manville Products Corp., was director of engineering before his appointment as assistant general manager to the Celite Division in July 1954.

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Mr. Henry Cragg has been elected to the new post of administrative vice president of Minute Maid-Snow Crop Frozen Foods, according to announcement by Mr. John M. Fox, president. He will have administrative responsibilities for corporate production planning and control, inventory management, warehousing and traffic, purchasing—other than fruit and co-pack—personnel, and operations research.

The same firm announces that **Mr. Robert H. Brown,** formerly district sales manager in New England, has been promoted to manager of the Mid-Atlantic Sales Division. Succeeding Mr. Brown in New England, will be **Mr. Hugh Fitzgerald,** formerly district manager for Connecticut.

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FMC's W. B. Bangerter

Food Machinery and Chemical Corporation's Canning Machinery Division has announced appointment of **Mr. Wm. B. Bangerter** as western sales manager of its Kitchen Equipment Department. Mr. Bangerter, whose sales activities will cover the 11 Western states, will headquarter at the Division's home office in San Jose, Calif. The firm also maintains a Kitchen Equipment Department office in Chicago, Ill., under the supervision of **Mr. Lyle M. Williams,** eastern sales manager for the balance of the states.

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Mr. Wallace E. Gordon, assistant director of sales of the Grasselli Chemicals Department of the Du Pont Co., Wilmington, Del., has been named director of the firm's Advertising Department. The former director, **Mr. Wm. A. Hart,** retired at age 65 at the end of August after a 31-year career with Du Pont. Mr.

Gordon joined the Du Pont Company in 1933 as a research chemist.

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The appointments of five new technologists at the Central Laboratories of General Foods, Hoboken, N. J., were announced by Mr. Harvey Murer, manager of the laboratories. The appointments include: **Mr. John V. Luck,** as associate technologist in phytochemistry; **Mr. Eugene J. Misiaszek,** as assistant technologist in packaging research; **Miss Nancy Ann Sudmann,** as junior technologist in product and process development; **Mr. Thomas M. Ott,** as junior technologist in product and process development; and **Mr. Maurice Winkler,** as junior technologist in engineering research.

◆ ◆ ◆

. . . to board chairman—E. P. Allis

. . . to president—J. W. Allis

Election of **Mr. E. P. Allis,** president of The Louis Allis Co., Milwaukee, Wis., since 1945, to the post of chairman of the Board, and promotion of **Mr. John W. Allis** from vice president to president, has been announced by the firm's Board of Directors. Mr. E. P. Allis states that he had recommended this action to the Board to enable him to continue to work closely with the new president in advance of his intended retirement in 1957.

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Two teams of research scientists at the USDA's Eastern Utilization Research Branch laboratory in Wyndmoor (Philadelphia), Pa., have received Superior Service Awards from the Department for discovering how to recover valuable fruit flavors normally lost in preserve manufacturing, and for developing a process which prevents stream pollution by dairy waste. The awards, each a bronze plaque with a silver medal, were presented by Mr. MacHenry Schafer, Washington, D. C., the Department's Director of Personnel. The fruit flavor group includes: **Roderick K. Eskew, Nicholas C. Aceto, R. Henry Morris, 3rd, Joseph B. Claffey, Clifford S. Redfield, Wister U. Hyde, Nelson H. Eisenhardt, John J. Skalamera,** and the late **G. W. Macpherson Phillips.** On the dairy waste research team were: **Dr. Sam R. Hoover, Dr. Nandor Porges, Lenore Jasewicz,** and **Mrs. Janet B. Pepinsky.** Mr. Skalamera and Mrs. Pepinsky are no longer members of the laboratory staff.

Another team of Eastern Utilization Research Branch scientists had earlier received the same award for developing a time- and labor-saving method of manufacturing cheddar cheese with improved body and texture from pasteurized milk. Members included: **Homer E. Walter, Dr. Ralph P. Tittsler, Robert E. Hargrove, James P. Malkames, Arthur M. Sadler,** and **Clair D. Mitchell.**

◆ ◆ ◆

Adams of Continental Can

Continental Can Company, 100 E. 42nd St., New York 17, N. Y., has named Dr. Frederick W. Adams, formerly research and development director of the firm's Millsplastic Division, as director of the department of chemistry of its Central Research and Engineering Division, it was announced by Mr. Curtis E. Maier, general manager of the Division. Author of about 30 publications on various chemical engineering operations, new IFT member Adams also holds 15 patents on new developments in that field.

◆ ◆ ◆

Mr. Eugene Finnegan, a member of IFT, has joined the staff of Stein, Hall & Co., Inc., 285 Madison Ave., New York 17, N. Y. He will work closely with the firm's sales representatives in the field, lending technical assistance on food production problems, particularly in dairy products. Prior to joining Stein Hall, he was associate professor of Dairy Manufacturing and superintendent of the dairy plant at Virginia Polytechnic Institute.

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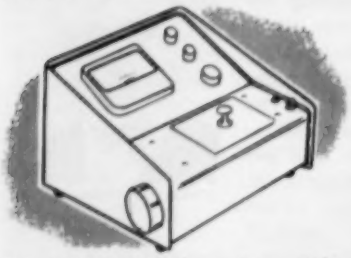
BECKMAN
BULLETIN DIGEST
NUMBER 5

SUGAR WHITENESS MEASUREMENTS with COLORIMETER



Here is the new Beckman Sugar Colorimeter—it provides a quick and accurate way to describe sugar whiteness so that everyone using it can obtain Color Index Numbers which are directly comparable. Now suppliers and users can talk the same language, with great ease! The Beckman Sugar Colorimeter was designed in close cooperation with the sugar industry . . . three years and several model changes were required before the industry committee gave its okay. Their latest report, to be released soon, says ". . . gives close agreement with the Beckman Model DU Spectrophotometer."

The Sugar Colorimeter comes complete with filters and two 10cm sample cells . . . all ready to use. The instrument is standardized with a colorless sugar solution or with distilled water . . . the sugar sample is dissolved in distilled water and absorbancy measured with the 420 $m\mu$ filter. Turbidity is measured with the 720 $m\mu$ filter, and subtracted from the first reading. Applying a simple formula gives Color Index . . . a number which will have the same meaning to a sugar refiner, a soft drink bottler, an ice cream maker, a baker or a confectioner.

A reprint of the first report of the sugar industry committee is yours for the asking. Your Beckman dealer will be glad to show you the Sugar Colorimeter in action . . . he'll even bring the sugar.

Your Beckman Dealer will be glad to demonstrate the Sugar Colorimeter as well as the Clinical Colorimeter, Flame Photometer, pH Meters and Spectrophotometers. For further information on the Sugar Colorimeter ask for Bulletin 68-84

Beckman Division
BECKMAN INSTRUMENTS, INC.
Fullerton 1, California

FOOD INDUSTRY TOPICS

Campbell Soup Co., Camden, N. J., has announced appointment of **Dr. Carl H. Krieger** as director of Basic Research. This is a new department formed to consolidate the various basic research activities of the company. In his new position, Dr. Krieger, formerly with the Wisconsin Alumni Research Foundation, will be responsible for directing research work in the fields of nutrition and chemistry of flavors, as well as fundamental research on ingredients.

◆ ◆ ◆

Mr. Paul Hutchinson has been appointed sales manager of the Laboratory Instruments Division of The Perkin-Elmer Corp., Norwalk, Conn., it was announced by Dr. Van Zandt Williams, vice president for sales and research.

EMPLOYMENT NOTICES

AVAILABLE: TECHNICAL DIRECTOR—Technical services. Ph.D. Food Technology. Sound background, research, product development and administration. REPLY BOX 436, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

FOOD TECHNOLOGIST

Developmental research on jams, jellies, natural fruit. Experienced in volatile flavor recovery from natural fruits. B.S. in chemistry or chemical engineering required for nation-wide food company with laboratory in Chicago area. Submit resume of education, experience and salary requirements. REPLY BOX 438, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

WANTED: Information Specialist. Needed by research group in field of animal nutrition and veterinary medicine. Duties: To conduct literature searches, maintain an abstract bulletin and assist in preparing technical reports. Training in chemical and biological sciences essential as well as some facility in writing and familiarity with technical literature. Location midwest. Please state full details and minimum salary requirement in first letter to BOX 437, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

PLANT SCIENTIST—Opening exists in West Coast laboratory of national organization for man with M.S. or B.S. in plant pathology or related plant sciences. Experience in fresh fruit and vegetable industry desirable. Submit resume of education, experience and salary range desired. REPLY BOX 439, Institute of Food Technologits, 176 W. Adams St., Chicago 3, Ill.

AVAILABLE: Food Technologist, M.S. equiva., 3 years research and development, 4 years varied industrial experience. Desires research or development position. Age 33, family. REPLY BOX 441, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

SINCE 1870 Food Ingredient & New Drug Studies
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Bacteriologists Chemists Pharmacologists
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Div. F, 1921 Walnut St., Philadelphia 3, Pa.

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S. W. ARENSON Director
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Ingredient evaluations • New products development — flour, shortenings, milk and other basic ingredients • Chemical and physical laboratory, bakery, spray dryer and other unit process equipment.

Schwarz
SERVICES TO THE FOOD INDUSTRIES
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• Analyses of food materials and products.
• Food plant design, process examination and control.
• Legal testimony and consultation on government regulations.
Founded 1867
Write for bulletin "Scientific Quality Control of Foods and Beverages"
SCHWARZ LABORATORIES, Inc.
230 Washington St., Mount Vernon, N. Y.

FOOD RESEARCH LABORATORIES, INC.
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Bernard L. Oser, Ph.D., Director
Research • Analyses • Consultation
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Biological, Nutritional, Toxicological Studies for the Food, Drug and Allied Industries
48-14 33rd Street, Long Island City 1, N. Y.

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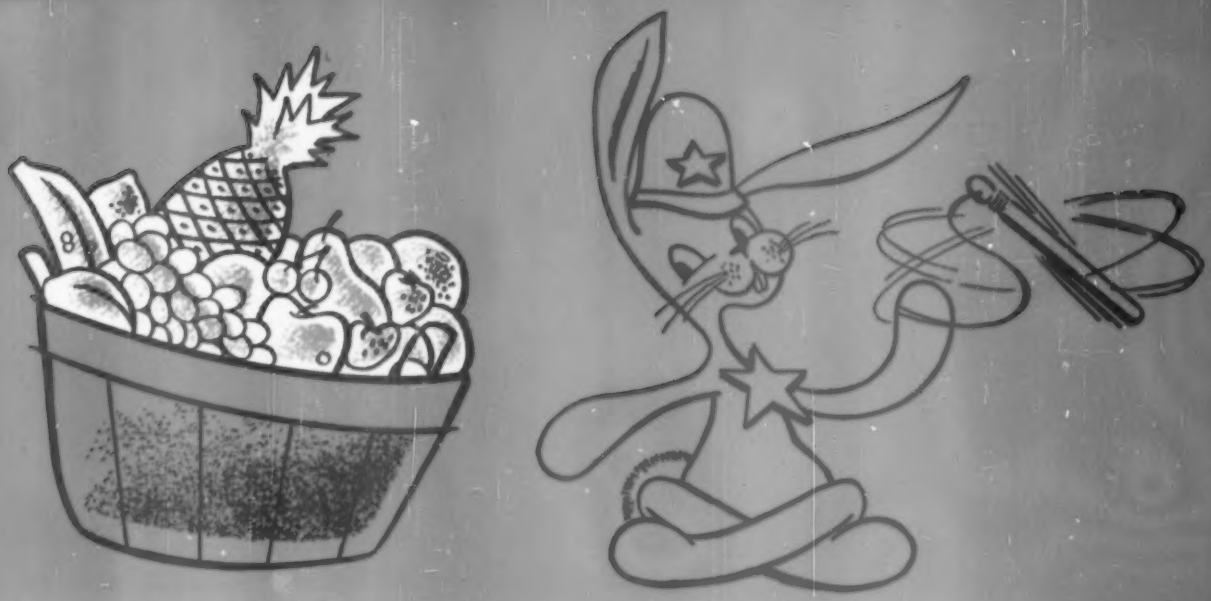

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with **Sealva** the hermetically sealed flavors.

The famous SEALVA process—of hermetically sealing minute droplets of flavoring oils within an edible gum film—provides a flavor in which even the most fugitive components remain unchanged in their fresh original state over extended periods of shelf-life.

SEALVA flavors—in commercial use for almost three years—give manufacturers a dry powdered flavoring material protected against oxidation, and volatilization.

SEALVA flavors have been enthusiastically adopted by makers of

- CAKE MIXES
- GELATIN DESSERTS
- CEREALS
- SUMMER DRINK POWDERS
- PUDDING MIXES
- DAIRY MIXES
- ICE CREAM MIXES
- CANDIES (pressed wafers)
- PHARMACEUTICALS

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